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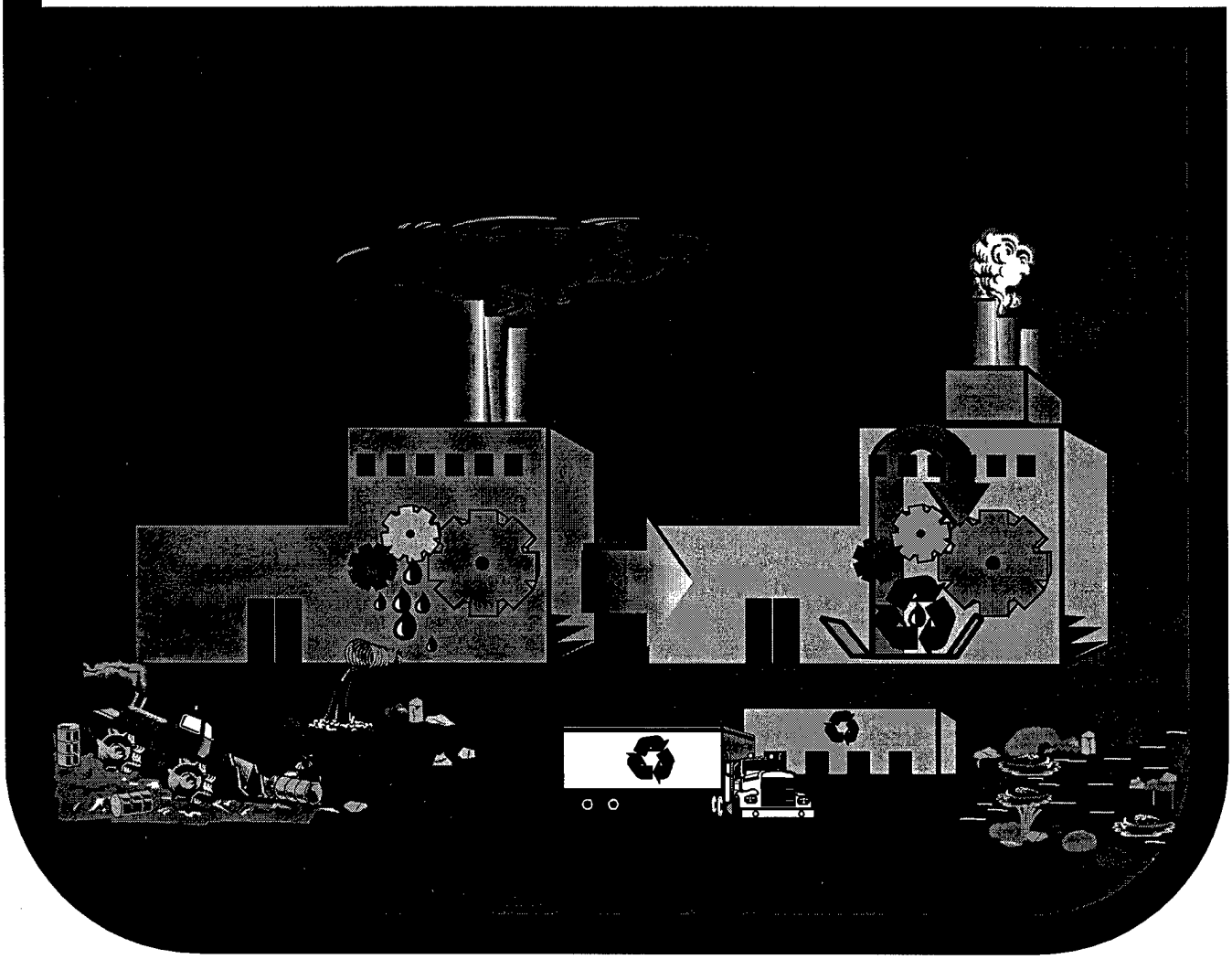
A BEST MANUFACTURING PRACTICES PROGRAM PUBLICATION

NAVSO P-3680

HOW TO BE GREEN AND STAY IN THE BLACK

ENVIRONMENTAL GUIDELINE DOCUMENT



DEPARTMENT OF THE NAVY

OCTOBER 1997

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HOW TO BE GREEN AND STAY IN THE BLACK

ENVIRONMENTAL GUIDELINE DOCUMENT

Preface

Do you have an environmental problem and no solution? Wouldn't it be great to know how others solved their environmental problems? Would you like a source for finding answers to your environmental problems? Do you need help on what to do with ***hazardous materials***? What about ***recycling solid waste***, ***waste minimization***, ***solvent recovery systems***, ***groundwater and soil cleanup***, ***chemical recycling***, *and* ***chemical management programs?*** Are you looking for a way to be environmentally sound and save money? This document contains examples of environmental best practices from industry, government, and academic institutions—and might have the solution to your environmental problem.

For more than a decade, the Navy's Best Manufacturing Practices (BMP) program's survey process has been a primary avenue for industry and government to present individual and distinctive success stories in the manufacturing disciplines. In February 1994, industry and government representatives met and discussed the idea of broadening the BMP program scope to incorporate environmental best practices. The idea resulted in the formation of the Environmental Best Manufacturing Practices (EBMP) program. Several meetings were held to define issues and goals:

Where would EBMP fit in the environmental community?

What environmental problems exist?

Which problems needed to be addressed immediately?

How could the EBMP program be a bridge to solving these problems?

The program's goal was to help industry find efficient, cost-effective ways to do business without re-inventing the wheel, and assume a constructive leadership role in the environmental area. Knowing that answers to many environmental questions already existed in the U.S. industrial base, the need to find these answers and publish them in a simple, useful, instructional document was the overall goal of the program. To achieve its goal, the EBMP program formed a working group. This document is the result of that group effort, and will be distributed in hard copy and electronically to thousands of representatives in government, industry, and academia throughout the U.S. and Canada. The document is available *at no cost* to any business, whether small, medium or large, needing help with environmental solutions. Information contained in this document can also be accessed via BMP's World Wide Web Home Page located on the Internet at ***http://www.bmpcoe.org***.

We do not have all the answers, by far. However, this guideline document contains examples of good, solid environmental processes, systems, and management techniques that could make a difference in your business. The EBMP program supports effective voluntary partnerships and technology transfer. One of our program's goals is to make a difference — environmentally — in what is produced and how it is produced. We believe this document is a giant step toward that goal.

Ernie Renner
Director, Best Manufacturing Practices

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Section 1

Introduction

Overview

In today's world, producing a good, reliable, environmentally safe product is crucial. To accomplish this task, government and industry must take into account environmental regulations, socioeconomic costs, and global competitive pressure. In the past, American industry focused mainly on compliance, cost avoidance, and remediation. We cannot continue to take this approach, and must become more proactive in balancing efficiency and cost with evolving environmental factors. By consciously designing for the environment, manufacturers promote pollution prevention; waste minimization; and product reuse and recycling. These practices not only improve the design and efficiency of new products, but also contribute to saving the renewable and non-renewable resources in our ecosystem.

The impact of environmental regulations is causing wholesale change in the Department of Defense and its contractor corps. Environmental issues are a critical part of the acquisition system process for the Department of Defense and U. S. companies that want to remain globally competitive. As one burdensome environmental law is stacked atop another, the challenge becomes even more arduous. Despite size, companies must keep current with the latest developments in environmental areas. In today's marketplace, everything sold aspires to be environmentally friendly — from missiles to paper cups — ***and it isn't easy being green.*** In the complicated environmental realm, going on instinct alone can cause more harm than good.

Recently the regulated community, and the regulators themselves, have recognized that programs designed to protect the environment can result in greater operational efficiencies and increase an organization's competitive advantage. By focusing on strategic environmental management, leaders can measure and optimize their return on investment. By treating environmental initiatives as a business investment, leaders can identify baseline costs and liabilities, and calculate the rate of return based on cost and liability reduction or competitive enhancement. Businesses are starting to recognize that environmental, health, and safety issues are not the enemy. The market for environmentally sound products and services is growing.

This document contains many solutions to environmental challenges facing industry, businesses, and programs today. Following are just two of many success stories:

- A company initiated a program to eliminate chemicals from its manufacturing process. They exceeded initial expectations to the extent that ***more than one million pounds of chemicals, including 600,000 pounds of CFCs, were eliminated years before regulatory deadlines.***
- Another company estimated cost savings from its ***wipe solvent implementation program resulting in an $8.2 million savings over a five year period.***

By using these guidelines, programs working toward ISO 14000 certification can be impacted; compliance with federal, state, and local environmental regulations can be achieved; and development of engineering curricula at colleges and universities can be realized. The estimated economic value to the U.S. industrial base can be substantial by using information that already exists and helping businesses and programs realize cost benefits through the avoidance of non-compliance related costs.

The environmental area has gained due recognition in recent years. As such, it is still a growing field, and related data and documents require constant evaluation and revisions. Therefore, this is a *living document* and will undergo change and refinement as technologies advance in the environmental field. The document provides basic information and successful applications of environmental best practices for incorporation by any company, government installation, or academic institution.

As a living document, updates will be conducted periodically. This is an opportunity to look at your activity, relate your success stories, and be part of the next guideline document. To assist in the update process, the Environmental Best Manufacturing Practices (EBMP) questionnaire is available on the Best Manufacturing Practices Center of Excellence Home Page at http://www.bmpcoe.org, or by calling 800-789-4267. All information submitted will be reviewed and compiled by the EBMP Executive Steering Committee Members. We encourage your participation.

Committee Members

The Environmental Best Manufacturing Practices (EBMP) guideline working group is comprised of voluntary representatives from industry and government. Their contribution to this document is greatly appreciated. We thank them for their participation, comments, and expert guidance.

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Ernie Renner	BMP Center of Excellence
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We extend special thanks and recognition to Darrel Brothersen, Rockwell Avionics & Communications, for his contribution to the Waste Handling/Reuse/Recycle section; Joe Phillips, Tennessee Valley Authority, for his contribution to the Pollution Prevention section; and Terry Payne, Lockheed Martin Energy Research Corporation, for his contribution to the Environmentally Conscious Manufacturing section.

Summary

Environment, health, and safety management, if considered a part of the manufacturing process, can become an efficient, cost effective factor that will reap rewards beyond expectations. This document was designed to compile as many environmental success stories as possible and provide the information to programs, companies, and institutions concerned about the future. Let's *all* ensure that future generations will enjoy an environmentally safe and sound world.

Section 2

Pollution Prevention

Introduction

Pollution prevention should be an integral part of every manufacturing facility. Are you installing new equipment? Changing a process? Purchasing new chemicals? Think pollution prevention. If you are starting a pollution prevention program, here are some rules you might want to consider:

- Obtain management support — very critical to a successful program
- Consider each step of the manufacturing process
- Identify raw materials used
- Identify waste streams
- Consider risk to employees
- Determine emissions/releases

Manufacturing practices that eliminate waste before it is created are the most efficient and cost effective of all environmental best practices. Eliminating pollution at the source is preferred. Reducing or eliminating materials, processes, or products is preferable to recycling, treating, and then disposing of waste by-products. Research shows that frequently, the true cost of waste in manufacturing can equal or exceed the payroll. The cost savings associated with waste reduction often recoup the cost of implementation in months. So, when considering pollution prevention in your company/facility consider the following:

- Source Reduction
- Recycling/Reuse
- Treatment
- Disposal

Documented in the following pages, are pollution prevention and waste reduction practices that have been found effective in specific industries. These companies have agreed to be identified in the hope that their experiences will help others solve similar problems. You are encouraged to investigate these practices and adapt or modify those that fit your situation.

Bell Helicopter Textron, Inc. - Ft. Worth, TX

V-22 and Pollution Prevention

Background

Elimination or substitution of hazardous materials during the products' life cycle is described, together with steps in partnering and jointly working pollution prevention (P2) issues.

The Pollution Prevention Program (PPP) Plan defines the Bell-Boeing V-22 Engineering Manufacturing Development (EMD) PPP. Specifically prohibited was the use of asbestos, ozone depleting substances, and surface coatings containing lead. Volatile organic compounds content in primers and topcoats may not exceed regulatory requirements.

- Identifying a hazardous materials listing was crucial and time-consuming. Families of chemicals were selected to avoid a long list. The plan addresses responsibilities of all functional groups in relation to P2 and implementation. Coordination and communication between functional groups, Boeing, and the customer are essential.
- Included was training of design engineers and all those involved in carrying out the plan.
- The logistics role is critical to the success of the P2 effort, especially as far as the customer is concerned.

Description

When selecting materials and processes, contract language requires the environmental impacts to be minimized during the life cycle (systems definition, design, engineering development, manufacture, operation, maintenance and repair) of the weapon system. The environmental impact is considered equally with other design criterion.

Results

Ultimately, the hazardous materials are identified, prioritized, and trade studies recommended. This plan requires justification of use of specific hazardous materials if they cannot be eliminated. A database conveying this information is given to the customer. Hazardous materials are prioritized

based on five factors weighed equally: (a) amount of material used on V-22; (b) toxicity of material to human health; (c) the environment; (d) disposal, handling, and storage method associated with waste products; and (e) legislation associated with use and disposal of the material.

Bell Helicopter used P2 framework previously established through prior manufacturing programs to achieve the V-22 P2 requirements.

Bell Helicopter has pursued and accomplished an effective measurement of P2 efforts. The measurement system must be credible, verifiable, and normalized. Bell is currently implementing a computerized Material Safety Data Sheet (MSDS) and chemical inventory database to allow more accessible information for P2 activities. Environmental considerations during life cycle and documentation of successes or difficulties is important to success.

City of Chattanooga - Chattanooga, TN

Chattanooga Manufacturers Association

Background

The Chattanooga Manufacturers Association (CMA) is a proactive organization that addresses issues affecting the economic development and stability of the Chattanooga manufacturing industry. With a membership of 240 representing 175 manufacturers, CMA represents the needs of its membership through a collective and united voice. A broad range of companies belong to the CMA, from large companies with 3,000 employees to small companies with five employees.

Chattanooga manufacturing is not as large of an industrial community as it was in the early to mid 1900s. However, manufacturing represents an important 23% of the Chattanooga economic base, and is an essential element of any plan for economic growth. The manufacturing culture has shifted, and the CMA recognizes that the future of manufacturing must address issues of environmental controls and equipment, computerization, robotics, mechanization, global competition, work teams, zoning regulations, product reliability, job requirements, waste reduction, Total Quality Management, Just-in-Time, and OSHA.

Description

The CMA introduced "The Six Ps"—property, permission, processes, people, products, and profits—as core areas effecting change. For example, permission is no longer exclusively a legal issue. Today the manufacturer must consider more stringent air, water, and solid waste regulations; bureaucratic difficulty in obtaining required installation and operating permits; increased numbers of government mandates; complicated zoning and site regulations; environmental equity, and other social issues. Processes are also no longer centered solely around previously strong foundry operations, food and food production, chemicals, machinery and metal fabrication, textile fibers and apparel production. The manufacturer must now account for process improvements that minimize waste at the source, pollution abatement equipment installation, mechanization and material handling practices, energy conservation practices, and introduction of alternatives for problem materials.

Results

In cooperation with its members, its committees, community and industrial leaders, and the Chattanooga Chamber of Commerce, the CMA has effectively examined and developed courses of action to address issues identified from the "Six P" core areas that impact manufacturers. Typical issues addressed include challenging perceived unfair utility rates imposed on manufacturers, developing acceptable compliance with EPA's clean-air act, awareness of environmental regulations, and identifying manufacturer's resource requirements to the academic community. The organization addresses issues that are justified while opposing practices that are bureaucratic excess. This association focuses energy on an issue, and objectively reaches a resolution. The CMA has repeatedly exercised more influence as a whole than manufacturers could individually.

Greenways

Background

During the late 1980s, Chattanoogans began to evaluate the assets that had been abandoned by factories and foundries along the Tennessee River. A citizen's task group realized that the whole riverfront should be considered and include Moccasin Bend, a former location of the Cherokee Indian tribe encampments, as well as the downtown area. Consequently, partnerships with the Tennessee Valley Authority, private groups, and the local government created the first section of the Tennessee River Park.

Description

A citizen's task force—the Greenway Board—was subsequently developed, and advocated a high quality greenway path along the riverfront, creeks, and scenic corridors that connected housing, parks, businesses, and tourist attractions. To assist in the planning and implementation, the City contracted with the Trust for Public Land, a nonprofit organization, to provide technical assistance, coordination, and land purchases, and land protection for the greenways. Land for the greenways and most of the easements have been donated.

Chattanooga is networking these greenways into a linear park reserved for environmental and recreational use. One greenway that follows the North Chickamauga Creek for more than four miles (of its proposed 15-mile route) connects to the Greenway Farm, a 180-acre facility used as a park and which features a renovated mansion used as a conference center. On the south side of the Tennessee River, the 22-mile greenway is 40% complete and will eventually link the Chickamauga Dam with the Tennessee Aquarium.

Results

Four other greenways will link the Tennessee Aquarium, parks, and neighborhoods while providing protected trails for people to ride bikes, jog, and walk. With the completed greenways and another 75-100 miles of greenway planned for the future, the community has generated pride and enthusiasm that is considered a benchmark for other communities.

Parks and Recreation Alliances with Non-Profit Groups and Private Industry

Background

Chattanooga's campaign for the quality of life for its citizens is reflected in the expansion of the Parks and Recreation Department. The department previously offered only basic, traditional programs because of limited resources, and clientele was normally limited to the poor inner-city. However, through Vision 2000, where the community reaffirmed that its recreational department was a quality of life ingredient, and because of changes in the local government, Chattanooga set out with objectives to use its recreational resources as much as possible and not duplicate services. Consequently, discussions with related private concerns were initiated where there was an interest in building a partnership. Over 50 non-profit and private organizations have been used since 1994 to expand and improve services.

Description

An example of these alliances is provided by a partnership established between the department and the Trust for Public Land to support the Greenway initiative. The relationship has saved the City over $60K annually and provided resources not locally available. The Trust for Public Land purchased the Greenway Farm, a 180-acre tract along the river slated for condominium development. With this purchase, the Greenway was extended, development for condominiums was halted, and a mansion on the property was converted into a Greenway Farm conference center for environmental education programs. A similar relationship was established with The Nature Center to provide oversight of the conference center and provide the environmental education programs. As a part of the lease, the City can bring inner-city children to the environmental education programs free of charge.

Results

As a result of a community interests survey, the City wanted to develop a climbing wall to educate citizens and help them develop climbing skills. A local outdoor supply company also wanted to provide a training facility for rock climbing. The City consequently leased a pier of the walking bridge to this company to develop the facility. The company provided the initial capital investment and the annual operating funds. A clause in the lease stipulates that the company provides over 400 hours of free instructional time to recreation participants from the inner city.

The success of the involvement of the nonprofit and private companies can be attributed to the quality-of-life issues Chattanooga is espousing, as well as the City actively seeking out partners, publicity from the two local newspapers, and the grassroots efforts to involve the community.

Stormwater Community Education Program

Background

Chattanooga uses an innovative and successful program to educate its general public on the importance of preventing the introduction of pollutants

into the natural waterways that run through the City. Operating on a small budget, the program uses several approaches to inform citizens of the consequences of improper disposal of various materials that may empty into the waterways.

Description

This public education effort started in 1992 with the distribution of a periodic newsletter, *The Clear Choice*. The newsletter focused on topics relating to stormwater management such as land-disturbing regulations, the federally-mandated National Pollutant Discharge Elimination System requirements, stormwater discharge permitting requirements, offers of Erosion Control classes, notification of awards won by the City for clean water activities, and other opportunities for personal involvement underway.

A particular, targeted concern addressed by this newsletter and other educational efforts was the typical "out of sight, out of mind" attitude that often accompanied the improper disposal of some materials such as:

- dumping car radiator antifreeze or engine oil down storm drains,
- performing car maintenance on city streets where leaking/drained fluids can end up in the storm drains,
- rinsing fuel spills from auto/truck accidents into storm drains,
- improper storage of discarded greases or cooking oils from restaurants, and
- uncontrolled erosion from construction sites.

Results

Chattanooga also created a water quality mascot called Clear Choice (CC) Otter to use as an informative and concerned tutor in pamphlets and other simple instructional materials. In addition to the informative material, items such as drink bottles and visors have been created to keep CC Otter—and what he symbolizes—in the public eye. A highly-popular, costumed version of CC Otter participates in many civic functions such as Earth Day celebrations, local festivals, and scouting events to continue educational efforts.

Other important educational aspects of water quality are presented in kits available to the public such as a "Dump No Waste—Drains to Rivers" stencil for storm drain grills. Doorknob tags describing the problems with pollutants being dumped into storm drains are also available for distribution, and are used when a pollutant is regularly entering the storm drains from a particular neighborhood.

All public relations efforts are paid for by stormwater permitting fees, and amounts to approximately 5% of the total Stormwater Management Department budget. Estimates placed at 60,000 local people have been directly reached since 1993 through the education and outreach programs, with a significant number being reached through the indirect programs. As a result, Chattanooga's residents continue to become more environmentally conscious and protective of their natural resources.

Environmental Court

Background

The Environmental Court Docket was established in 1991 to address compliance to environmental ordinances and create a better living environment within the City. Prior to this time, Chattanooga had little ability to enforce compliance with housing, zoning, and building ordinances. Although cited in court, cases were not given the same consideration by judges as other cases, thereby making enforcement difficult and leaving inspectors disillusioned and helpless. The docket was crowded with more serious criminal or traffic offenses that required the court's attention. The condition continued to deteriorate and the number of violators increased.

Description

One afternoon each week was set aside to hear only these environmental cases, allowing the court to send a clear message that Chattanooga was going to clean itself up. In addition to hearing the cases in the courtroom, the judge has held on-site hearings (as necessary) to better understand the alleged ordinance violations and ensure fair and equitable treatment to all parties.

Results

Since the Environmental Court Docket was established, the City has seen the compliance rate increase from 38% to 87%, City inspectors have renewed conviction in their jobs, and communities in Chattanooga are being restored. Safer and cleaner houses are made available to citizens, and the number of illegal dump sites has been greatly reduced.

Hamilton County Air Pollution Control Bureau

Background

Following Chattanooga's designation in 1969 as one of the worst air polluters in the country, the City sought and received State approval to develop local air pollution control regulations. This was a significant effort as Chattanooga was eighth in the nation in manufacturing jobs per capita. It was also a transportation hub and home to many foundries, and locally available soft coal was the fuel of choice. The community acknowledged that success would require significant support of companies affected, and that local regulations must also comply with state and federal standards.

Description

The Hamilton County Air Pollution Control Bureau was established to develop needed regulations. In an effort to obtain input from local manufacturers, draft regulations were shared with industry, of which the major stakeholder was the Chattanooga Manufacturers' Association (CMA). Significant effort was made to resolve issues with this highly respected and proactive group. Today, the Bureau is governed by ten directors appointed by the Mayor and the County Executive. It maintains a staff of 20 personnel, mostly engineers, with an annual budget of $1.2M.

When reasonable consensus is reached, proposed regulations are recommended for approval by the 11 legislative bodies within the City and county. The Bureau has been highly successful because the legislative bodies and local industry understand and trust the consensus-building efforts which precede the recommendations. Although the Bureau is responsible for enforcement, it uses seminars, workshops, and information sharing with the community to facilitate compliance. Pollution prevention opportunities and best practices are shared with citizens and regulated industries.

Results

A central philosophy of the Bureau is that companies will reduce emissions if a competent, credible professional staff can demonstrate that cost savings will result from doing so.

Economy Surplus Power for Wastewater Treatment

Background

The Moccasin Bend Wastewater Treatment Plant in Chattanooga is a major user of electricity, and actively strives to cut costs and still maintain high levels of service to City residents and the immediate area.

Description

In 1989, the City entered into an agreement with the Tennessee Valley Authority (TVA) to purchase Economy Surplus Power (ESP) from the TVA that would save the City tax dollars and still meet the power requirements for operation of the Wastewater Treatment Plant. Under this agreement, the City agreed to a baseline of 3000 KW at regular rates and 3000 KW of ESP at greatly reduced rates. Any use by the City over the accepted total usage would carry significant penalties. In addition, the City agreed that TVA could interrupt (discontinue) the ESP at any time, requiring the treatment plant to cut back to a maximum of 3000KW within five minutes. The City has experienced only two interruptions since 1994, and both interruptions were caused by unexpectedly high demands for electricity, thereby eliminating the surplus available to the City.

The ESP agreement has prompted the wastewater treatment plant personnel to become more cognizant of power usage and install safeguards to adjust processes and monitor use. The plant has also installed two, 35-million gallon equalization basins to handle sewage for treatment during peak requirements.

Results

The savings realized in the first year amounted to $357K to the City, and for 1995 equaled $395K. As further improvements in monitoring and control systems are made at the treatment plant, outyear savings are expected to be even greater.

Dover Air Force Base - Dover, DE

Hazardous Materials Pharmacy

Background

The Hazardous Materials (HazMat) pharmacy was conceived by the Air Force to control and track hazardous materials usage on bases. With this goal in mind, Dover Air Force Base (DAFB) was tasked to implement the HazMat pharmacy concept to

work out the implementation problems. DAFB, along with all other Air Force bases, have also been tasked to reduce hazardous waste by 50% by the year 1999 when compared to the baseline year of 1992. The best way to reduce hazardous waste is to not bring hazardous materials onto the base. With this in mind, DAFB has added HazMat/hazardous waste reduction as a goal to the HazMat process.

Description

All materials used on the base, which were classified as hazardous by the criteria as toxic, corrosive, reactive, or flammable, had to be obtained through the pharmacy. Outdated or excess stock were eliminated from base stores and shop storage as hazardous waste if it could not be recycled. This resulted in an immediate increase of hazardous waste disposal. Some materials became more difficult to obtain for base personnel, which delayed some base operations. This bottle neck has caused a review of criteria as to what constitutes hazardous material. The pharmacy is also to find nonhazardous substitutes which can be used in the various industrial operations on base in place of hazardous materials currently used.

Results

The implementation of the pharmacy is helping to bring about the goal of reducing hazardous waste. Based on the first two quarters of 1996, the projected hazardous waste disposal for this year was 46% lower than the 1992 figure of 128 tons.

Part of the goal was to reduce the usage of EPA 17 chemicals, or ozone depleting chemicals (ODCs). The baseline year of 1992 usage was 46,154 pounds. The usage for the first half of 1996 was 2,909 pounds.

Has the implementation of the HazMat Pharmacy achieved its goal? Not entirely, but it is well on its way and has contributed greatly to a better environment.

ITT Defense and Electronics - McLean, VA

Development and Implementation of Multifunctional/Multiunit Chemical Use Reduction Teams

Background

In 1989 ITT Defense (later ITT Defense and Electronics (ITTD&E)) was very interested in expanding the use of Multifunctional and Multiunit teams to address issues of general interest across the Company. While most of the Company's locations had developed local process improvement teams, these efforts rarely extended beyond the individual Units. In areas of shared need, these independent efforts inevitably led to unnecessary duplication of effort. Chemical source reduction was selected as an example project which could demonstrate the benefits of interunit cooperation.

Most manufacturing organizations historically selected chemicals and manufacturing procedures based principally on ease of use and effects on product quality. Alternative chemicals were rarely considered once an effective chemical was selected. This program was designed to change the basic processes for selection and use of chemicals.

Description

ITTD&E established a company-wide Chemical Source Reduction Team (CSR) to lead efforts to reduce use of chemicals. Team members were selected by Unit management and led by each location's Operations or Engineering organization. This leadership structure was required to ensure that those who control the use of chemicals would evaluate replacements and implement any process modifications that might be required. This was a change from the traditional belief that a local EHS Coordinator was responsible for all such matters.

Each Unit's team first reviewed all operations where chemicals were used and prepared a Process Modification/Chemical Elimination Potential Report. From this report annual Source Reduction Implementation Plans (SRIPs) were developed. Each of these documents is reviewed with Unit and company senior management, and its progress is evaluated through monthly metrics and quarterly company-wide team video conferences. On an annual basis, each location provides a summary of progress and develops a new SRIP.

Results

The program exceeded initial expectations to the extent that over 1 million pounds of chemicals, including approximately 600,000 pounds of CFCs, were eliminated from ITTD&E manufacturing processes, years in advance of any regulatory deadlines. Annual chemical usage has been reduced by over one million pounds. In 1994 alone, almost 500,000 pounds of chemicals were addressed for an additional annual savings of almost $600,000. This success reduces the potential for future damaging and costly leaks or spills which can plague older manufacturing locations. It also brings the total

program to date an annual savings of over $3 million in avoided purchase, handling, and disposal costs.

An additional benefit from this effort has been the ability to anticipate customer requirements, and beat any chemical restriction deadlines they might impose. The success of this project at ITTD&E has also ensured continued support for its chemical source reduction program. The participation of employees from many different parts of the organization in this effort has led to a greater understanding of its EHS goals. The Company has instilled in its engineering and manufacturing process designers a new awareness of their responsibility to evaluate the hazards and potential life cycle costs of a new chemical before they introduce it into a process. They are also more attentive to the consequences of their process management decisions.

Mason & Hanger Corporation - Pantex Plant - Amarillo, TX

Energy Conservation

Background

A Presidential Executive Order issued in March 1994 instructed federal agencies to reduce overall energy use in federal buildings by 30% by the year 2005 from 1985 energy use levels; increase overall energy efficiency in industrial federal facilities by 20% by 2005 using 1990 as the baseline year; and minimize use of petroleum products at federal facilities by switching to less-polluting alternative energy sources. It also directed agencies to design and construct new facilities to minimize life-cycle costs through energy efficiency and water conservation technologies and use passive solar design and active solar technologies wherever cost effective.

Prior to this event, the Iowa Army Ammunition Plant (IAAP) had already undertaken an energy conservation program that met or exceeded the goals called for in the Executive Order.

Description

In 1985, Mason & Hanger (M&H) formed the IAAP Energy Council, chaired by the Facilities Engineering Energy Manager, with a main goal to reduce energy use throughout the facility and eliminate unnecessary overhead or operating costs. Members of the council included the engineering division manager, mechanical division manager, operations division manager, transportation and services manager, a representative from the comptroller, and bargaining unit representatives. The Council met quarterly to review past accomplishments and develop new initiatives which would meet their charter.

This program has accomplished many milestones including the establishment of a energy monitor program through which volunteer employee monitors identify targets of opportunity to reduce energy usage. The facility also converted to gasohol use in M&H's fleet of vehicles for an annual savings of over 10,000 gallons of gasoline per year. Building consolidation studies are ongoing, as well as an active review of all new construction and renovation at the facility with emphasis toward energy efficiency. The establishment of a dynamic energy resource management plan has been established, and the work week of the employees was modified from an eight-hour, five-day to 10-hour, four-day work week.

Results

Through the efforts of the employees at M&H, the IAAP documented energy cost avoidance of over $1.32M during the period of FY85 through FY93. IAAP has adopted the policy of reducing the demand for energy as being immediately more effective than increasing the supply.

Treatment of High Explosive Contaminated Groundwater

Background

Results from drilling test wells showed that past practices of flushing contaminates into drainage ditches at the facility had contaminated only perched aquifers and underlying flats and not the main drinking water aquifers used by many states in the southwest. This prompted the need for a study on groundwater treatment.

The treatability study was tasked to:

1. demonstrate that the groundwater level could be lowered sufficiently to expose the capillary fringe zone for volatile contaminant removal by vacuum;
2. assess the ability of the system as designed to expose the capillary fringe zone and remove volatiles by directing air from passive vent wells through the groundwater extraction wells;
3. determine optimum well spacing and the radius of influence for additional or future groundwater and or vapor extraction wells;

4. assess the ability of the dual phase groundwater/vapor extraction to be operated over an extended period of time in which to obtain reliable design parameters and other performance data for refinements to the existing system or a full scale treatment system;
5. assess the effectiveness of the carbon absorption system for removing HE components from the groundwater; and develop field-proven design criteria and equipment specifications for future remedial activities at Pantex.

Description

The study showed that HE contaminations of groundwater could be removed and remediated by dual phase extraction of unsaturated and saturated zones. The modified design calls for the same drilling of dual-phase wells along with the strategic location and drilling of injection wells to reuse the decontaminated water. Geological survey data and computer modeling provides needed information to maximize the treatability area and optimize well placement.

Results

Test wells were drilled to locate and define the flume of contamination. From the test well data, Pantex engineers determined where to drill the required dual-phase wells to begin decontamination. After installing the system, data and analysis revealed that the treated groundwater was of sufficient purity to allow its reuse, thereby avoiding pumping it to the wastewater treatment facility for further treatment and disposal. These findings allowed Pantex engineers to modify the process design. By successfully applying the results from the treatability study on high explosive (HE) contaminated soil and groundwater, Battelle - Pantex has been able to treat the soil without the risk of lowering the water table in treated or downstream areas.

Pantex Pollution Prevention

Background

With increasing requirement for the management and assessment of pollution problems, Pantex developed a program to evaluate and address pollution issues.

Description

Pantex's successful Pollution Prevention (P2) Program relies heavily on an initial Pollution Prevention Opportunity Assessment (PPOA) that emphasizes implementing preferred options to pollution prevention. The eight steps to the Battelle-Pantex assessment include selecting a waste stream and defining boundaries; establishing a PPOA team and appointing a team leader from the P2 group; performing a material balance of materials crossing the system boundaries; developing options; analyzing options; selecting the preferred option; implementing the preferred option; and validating the impact of implementing the preferred option. The Pantex P2 Program does not close out a project until after the preferred option is implemented. This effort includes evaluating the performance of the members of the P2 group by assessing the number of implemented P2 projects.

Projects are selected for the P2 program based on consideration of the Pantex Plant Top 150 Waste Stream List, employee suggestions (including a program where employees can share in dollar savings realized by implementing suggestions), and material evaluation forms.

Results

Employee attitude has been affected positively by training, by the P2 group realization that they are a service organization, by working to keep the customer happy, and by validating the results to ensure that the customer remains happy. This has resulted in a 756% return on investment of annualized savings associated with FY95 P2 projects.

McDonnell Douglas Aerospace - St. Louis, MO

Flashjet™ Coating Removal Process

Background

MDA (St. Louis) recently obtained a patent for an automated robotic technology identified as the FLASHJET™ Coating Removal process. This FLASHJET™ process uses a powerful pulse (15-23J/sqcm) of high intensity light to destroy the molecular structure of surface coatings. Simultaneously, a low pressure stream of dry ice particles cools the surface and sweeps away the ablated coating residue. This process allows removal of any coating from any surface with extraordinary precision, leaving no damage to substrates, no media intrusion, no corrosion potential, and an absolute minimum waste stream.

Description

The system contains a color sensor subsystem which controls lamp power during stripping to prevent substrate damage. This allows the system

to strip multiple layers of paint from the substrate while leaving the primer intact, ready to be repainted immediately. Additionally, FLASHJET™ was designed to address environmental impacts and worker safety/health issues. It filters hazardous solids from the waste stream, releasing an exhaust with only 10 ppm light hydrocarbons. Any removed waste is captured in disposable filter bags so operators are not exposed to dangerous by-products.

Results

Other benefits include worker acceptance, improved productivity, reduction of hazardous waste, environmental compliance, and reduced operating costs. For example, the cost of paint removal with the FLASHJET™ is approximately $3.74 per square foot, depending on geographic location. With chemicals the cost is $33.61 per square foot and with plastic media blast it is $15.40 per square foot.

MDA (St. Louis) has the first production model of this machine and is currently going through a series of mechanical validation tests for many different material types and manufacturing processes. There is no limit to the number of times the FLASHJET™ process can be applied to aircraft surfaces. The system has been fully qualified by the FAA for paint stripping applications on all of McDonnell Douglas aircraft structures and all Air Force F-15E program parts. MDA (St. Louis) is working on approval of this process for Airbus Industries, Boeing Aircraft, and Navy and Army products.

Future plans include the design and manufacture of a second generation FLASHJET™ System for marketing by MDA (St. Louis). There is significant interest in this product from both U.S. repair facilities and foreign governments.

Millar Western Pulp (Meadow Lake) Ltd. - Saskatchewan, Canada

Pollution Prevention

Background

Millar Western Pulp is actively pursuing reduction and elimination of air emissions, both particulate and gaseous. Particulate emission sources are being identified and testing is on-going to determine particulate characteristics and mass loadings.

Results

This information will be used to develop the best plan for dealing with the emissions. A similar approach is being used to deal with malodorous volatile organic compound emissions.

Process Waste Minimization

Background

Loss of fibre through debarking of logs and rejection fibre during cleaning leads to a significant loss of feedstock that must be treated through incineration. Work is being done on recovering as much of this fibre as possible in order to maximize fibre usage.

Results

The environmental benefits would be the need to harvest less trees to meet customer needs and incineration of less material with a concomitant decrease in CO^2 emissions. Economically, decreased production costs would be realized through better utilization of feedstock material.

Pacific Northwest National Laboratory - Richland, WA

Reduction of Radioisotope Use for Molecular-Biological Analyses

Background

A number of routine molecular-biological analyses, such as quantifying the levels of gene expression in cells, were based on the use of 32P-labeled DNA. As a consequence, a substantial amount of time was required for radiological control technicians for the performance of relatively routine experimental work. Advances in biotechnology have led to the development of fluorochrome-based DNA labeling reagents that can be substituted for radioisotopes in the majority of molecular-biological analyses.

Description

As part of an overall effort to cut operating costs by reducing the use of radioisotopes, the Molecular Biosciences Department invested in a Molecular Dynamics FluorImager SI. The device is capable of detecting a variety of fluorescent labels in DNA samples, and its availability led to an almost complete elimination of the use of radioisotopes for a number of routine analyses. In fiscal year 1995, the time of approximately one full-time equivalent radiological control technician was required for all departmental operations.

Results

As a consequence of the efforts to minimize the use of radioisotopes, including the purchase of the FluorImager, the projected need for radiological

control technician coverage for fiscal year 1997 is 0.1 full-time equivalent, yielding about $100,000 in savings annually, as well as waste disposal savings. This waste-minimization activity will avoid using ~20 mCi of 32P and avoid 100 L per year of liquid waste.

Rubbercycle

Background

Nationwide, one to two billion used tires are stockpiled awaiting disposal, and 250 million more are added to that number annually.

Description

Recycling waste-tire rubber into new tires has not been successful in the past because waste rubber does not bond reliably with virgin rubber. Pacific Northwest developed a new bioprocess to change the surface chemistry of waste-tire rubber to enable it to bond with virgin rubber, making it possible to mix 20 percent recycled rubber with 80 percent virgin rubber to make new tires.

Results

Taxpayers will save $200-400 million annually when this technology is implemented on a full scale. Approximately 65 million tires could be recycled annually. This represents recycling about 26 percent of the annual waste stream, more than double what is currently recycled.

Polaroid Corporation - Waltham, MA

Product Safety Emission Testing

Background

The Polaroid Corporation regularly conducts product safety emission testing to determine how its products are impacting the operational environment. Ongoing research continues to establish limits and guidelines for indoor air quality in occupational settings and for volatile organic compound (VOC) emissions from various sources such as furniture, carpets, and office equipment. Many indoor air quality problems associated with VOC emissions have been documented. Polaroid conducts tests to characterize and quantify VOC emissions generated and emitted during the operation or use of its products.

Description

Polaroid's test method was adopted from the ASTM D 5116-90 procedure entitled *Small Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials and Products* and modified to allow on-location testing of large manufacturing unit operations. The test chamber was constructed of wood and plastic sheets. Prior to product testing, background measurements were recorded on an empty test chamber, without equipment or materials present, so that VOC emissions present from the chamber's construction materials and ambient air could be quantified and subtracted from the product test results. Since the chamber was not airtight, the ventilation rates also had to be measured and adjusted in the test results. Measurements were performed via two techniques: Summa evacuated air canisters and Carbotrap solid adsorbent tubes. Both techniques produced measurements in good agreement with one another.

Results

Examples of products tested include the Helios Medical Imaging System, an identification card production system, and Polaroid film packages. Figure 2-1 shows the test chamber configuration for the Helios Medical Imaging System. Results confirmed that all products tested well below the problematic levels or concentrations of VOC emissions. Polaroid has evaluated all products to determine the requirements for testing and the potential for VOC emissions.

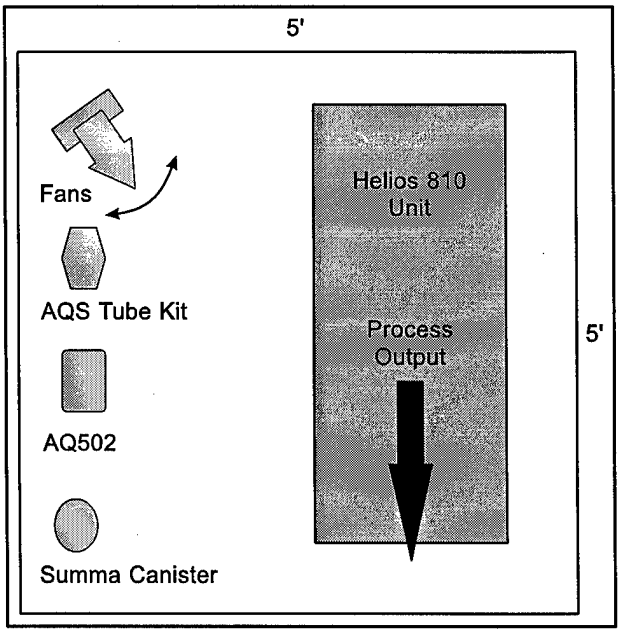

Figure 2-1. Test Chamber Configuration of Helios Medical Imaging System

Activity-Based Risk Management Performance System

Background

In 1994, Polaroid began implementing an Activity-Based Risk Management Performance system to improve the safety record of its Components Division plants. To recognize, encourage, and reward employee participation, the system used safety metrics which focused on the positive aspects of injury prevention. The positive metrics also helped in identifying and correcting underlying factors that could lead to injuries.

Description

Polaroid solicited 50 high risk situations (HRSs) from its five Components Division plants. These solicited targets represented chronic-type issues that had a high potential for serious injury and could not easily be resolved. For each target, Polaroid developed a risk matrix which plotted the likelihood of an incident versus the degree of consequence. Safety professionals then reviewed the risk matrices pertaining to their division.

Results

In December 1996, Polaroid exceeded its two-year success criteria goal of 65 targets by reducing the risk of 73 targets (Figure 2-2). The goal for 1997 is to reduce the risk of 25 targets (out of 50 identified). As of March, Polaroid reduced the risk of two targets. One situation involved refinishing a warehouse floor so forklift operators could drive on a smoother surface. The original surface contained several cracks that had the potential of snagging equipment, tipping over forklifts, and severely injuring operators. As a serious/critical risk, this situation provided a one-in-a-hundred (quite possible) likelihood of an incident occurring. By resurfacing the floor with an epoxy finish, Polaroid protected its building in the event of a hazardous waste spill, provided a non-cracked surface for its forklift operators, and reduced the situation to a minor/marginal risk with only a one-in-a-million likelihood of an incident occurring. The second situation involved the potential for fire, vapor exposure, and back injury to an operator when centrifuging a chemical compound. Assessed as a potential serious risk, the situation had an incident potential of occurring once every five years. By moving the chemical compound preparation to a pressure nutsche, Polaroid reduced the situation to a minor risk with an incident potential of occurring once during the plant's lifespan. In addition, exposure, drum handling, and flammable vapors in the plant were minimized.

Monthly tracking of the risk reduction metrics began in June 1994 and continues as an ongoing process. Polaroid revises its target list annually to ensure the top 50 HRSs are represented. The success rate of the project has exceeded original expectations, and may be attributed to the positive focus of the safety metrics and the involvement of the Components Division's managers.

Emergency Planning Program

Background

Designing and establishing an emergency program for any business is a challenging but necessary task. The philosophy behind Polaroid's Emer-

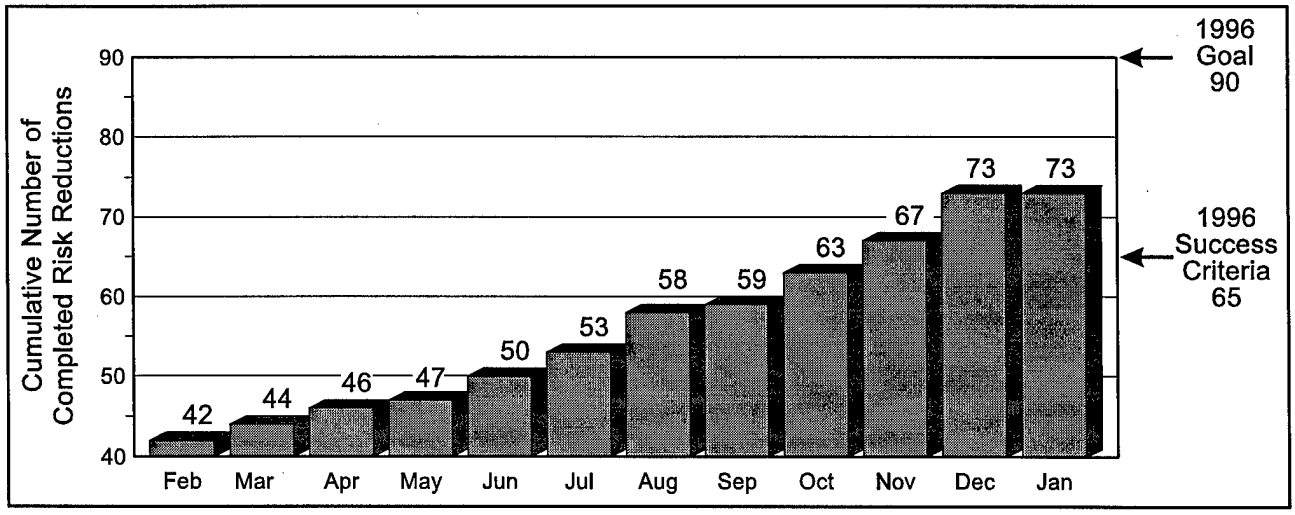

Figure 2-2. 1996 Risk Reduction Metric

gency Planning program is prevention and preparedness as equal partners in any emergency situation. Polaroid mandates that all divisions have preparedness plans which are integrated with the building, site, and community plans. Polaroid audits and updates its preparedness plans at least yearly. In addition, an emergency procedure manual addresses preparedness, prevention, response, and recovery. These manuals cover in detail the aspects of how to handle an unexpected crisis in a controlled, effective manner. In effect for more than 20 years, Polaroid's Emergency Planning program relies on the site's fire administrators, 40 volunteer emergency personnel, and outside contractor support as needed.

Description

Each year, the Emergency Planning program trains 100 to 150 people in the technical handling of emergency equipment and the use of procedures. This approach ensures the minimization of personal harm, property loss, and business interruptions. Other features include working with the surrounding neighborhoods and the local, regional, state, and federal agencies to establish emergency response procedures. Low level emergencies could occur each week. By using appropriate safety measures (e.g., emergency control stations, in-house emergency numbers, walkie-talkies, three to five minute response time), damage can be minimized and overall goals can be met. High level emergencies require critical decisions concerning resources and activities to be made under tremendous stress. Through the Emergency Planning program, planning and organization ensure the emergency will be handled in an efficient and effective manner that lessens personal harm and property loss.

Results

Through its Emergency Planning program, Polaroid is guarding its livelihood by protecting its personnel, processes, chemicals, machinery, and equipment. Designed as an emergency control program to meet all eventualities that can be reasonably anticipated, the company strives for excellent control, not perfection.

Engineering Controls

Background

Polaroid's philosophy emphasizes minimal exposure of chemical hazards to its employees through engineering controls. Engineering controls are employed to reduce worker exposure limits to well below regulatory limits. However, in those cases where employees cannot be completely protected through engineering control methods, personal protection equipment is then used.

Description

Polaroid developed state-of-the-art engineering controls to reduce chemical hazard exposure of its employees. Dust and fumes are vented out of the working area, and solvent emissions are sent to either a vapor recovery system or a thermal destruction pollution control device.

Results

These practices reduced worker exposure in the chemical facilities by 98%. In addition, the facility's layout places the tank farm and hazardous waste storage at a remote distance from the process and administration areas. Table 2-1 describes the engineering control features used in the Chemicals Manufacturing Plant.

Polaroid has a proactive approach to employee protection. This approach provides a better working environment for the employees and produces an overall high rating in employee satisfaction.

Pressure Nutsche

Background

Since 1988, Polaroid has been implementing a multimillion dollar program to replace the traditional centrifuges and dryers at its Chemical Operations Division with pressure nutsche technology. This change has been improving the company's Toxic Use and Waste Reduction performance and will reduce the Division's air emissions by 80% in 1999.

Previously, products were isolated; washed on filter presses or in centrifuges; and dried in vacuum tray dryers. These dryers produced high VOC emissions, required labor intensive material handling, and had long cycle times. The process also exposed employees to VOC emissions, solvents, and fire risks. Pressure nutsches work as self-contained vessels to filter, dry, and separate chemical mixtures while removing vapors and emissions. Polaroid introduced pressure nutsches as a means to improve safety for employees, prevent pollution, and provide increased operational performance. The nutsches have also been accepted by environmental agencies as complying with the Clean Air Act requirements. To offset the high cost of pressure nutsches ($2 million each), Polaroid has been upgrading its facilities gradually.

Table 2-1. Chemicals Manufacturing Plant

BUILDING FEATURES	
Explosion Proof Features:	Electricity Isolation Grounding Clamps Conductive Plastic Static Discharge (PPE-footwear)
Building Construction:	Blow-out Walls Automatic Shut-off Valves (Panic Buttons) Special Fire Extinguishing Equipment Solid Walls Protect Staging Areas
Ventilation:	General 6 to 10 Air Changes Per Hour Emergency Exhaust Ventilation Local Exhaust Ventilation (Hoods & Enclosures)
Building Utilities:	Nitrogen - Inerting Gas Special Cooling Systems (Exothermic Reactions) Automatic Exothermic Controls & Alarms Emergency Generators for Electric Power Hydraulic Fluid Systems Vacuum Pumps, Liquid Transfers
Control Room Monitoring of Processes	
PROCESSING EQUIPMENT	
Reactors (Rupture Discs, Sampling Devices, Bottom Valve Shut-offs) Condensers (Relief Valves) Centrifuges (Safety Interlocks, O_2 Analyzer, Static Charge Measurement) Dryers (Conical, Tray, Rotary) Filters (Filter Breakdown Area) Distillation Columns Storage Tanks (Raw Materials, Waste Solvents, etc.) Pressure Nutsche (Benefits of Operation)	
Reactor Area - Reactors in General:	Ventilation (Layout) Special Controls (Location of Control Panel) Special Valves (Fail-safe, Rupture Disk) Charging & Sampling Procedures Polymer (Monomer Chemistry) Worker Protection
Filters, Centrifuges, Pressure Nutsches, etc. - Separating Equipment:	Safety Procedures (For Separating Solids) Ventilation (Layout, Worker Location) Other Hazards (Static Electricity, Dust & Solvent Process Inerting N_2 & CO_2 Worker Suffocation)
Weighing & Drying:	Ventilation (Layout, Worker Location) Impact of Improper Weighing Static Electricity (Dust)
OTHER FEATURES	
Remote Tank Farm - Solvent Storage Area:	Safety Aspects (Ventilation, Grounding Clips) Spill Containment, Double Walled Tanks, Leak Detection Vapor Recovery Groundwater Contamination Monitoring

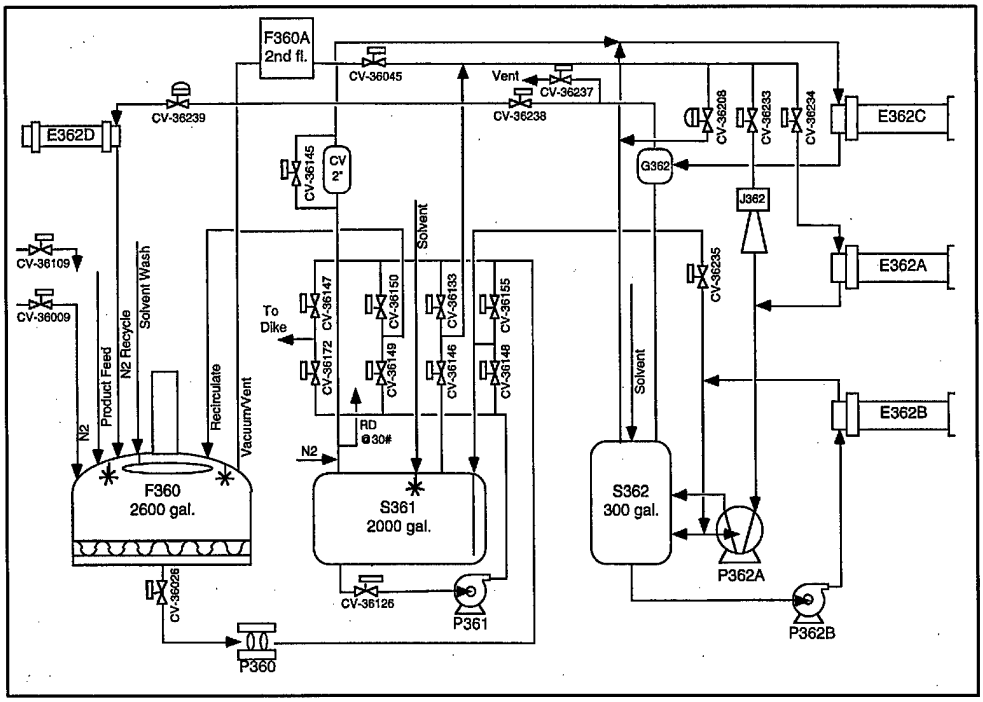

Figure 2-3. F360 Pressure Nutsche System

Description

Polaroid modified the pressure nutsches to facilitate its material handling and cleaning operations. Figure 2-3 shows a schematic of a typical pressure nutsche installation. Benefits gained by Polaroid over the past five years include a decrease in baseline VOC emissions from 180 to 40 tons per year; a 95% reduction in VOC emissions from filtration and drying operations over traditional processes; and an estimated 20% to 30% increase in solvent collection for on-site reuse or off-site fuel burning.

Results

Pressure nutsche technology has also improved employee safety by reducing solvent exposure, minimizing drum handling; and decreasing fire hazards from flammable solvents. Employees are no longer handling solvent-wet cakes. Operational benefits include improved efficiency, reduced cycle times, increased product yields by 2% to 5%, and reduced labor hours.

Volatile Organic Compound Abatement System

Background

To meet air pollution standards levied in 1984, Polaroid had to either revise its air emissions or face a shutdown. At the time, Polaroid had been releasing more than 2,500 tons of VOC emissions into the air annually. Emissions were generated from the drying ovens associated with film coating equipment. Direct-fired, continuous-burn incineration was a possible solution, but its associated high-energy consumption cost was a drawback. Polaroid needed a way to eliminate VOCs at a reduced energy cost. In response, Polaroid designed the specifications of the VOC Abatement system. The system's (Figure 2-4) cost was $5 million and went on-line in January 1985.

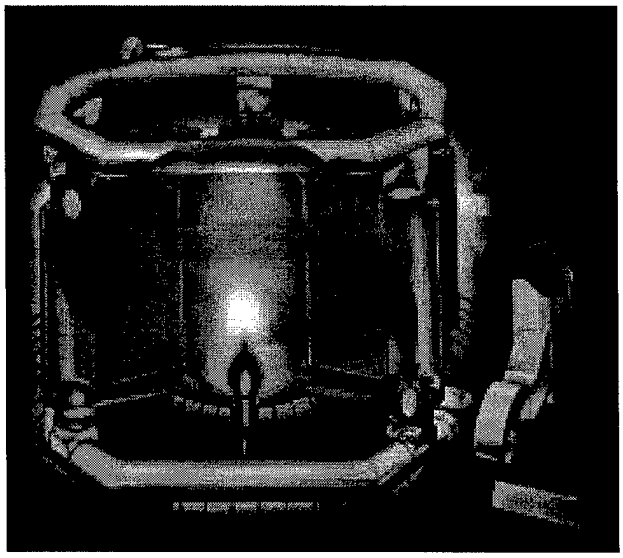

Figure 2-4. REECO Incinerator

Description

Built by Regenerative Environmental Equipment Company (REECO), the VOC Abatement system was a high-efficiency regenerative cycling incineration system which abated the hydrocarbons contained in solvent laden process exhaust. Contaminated fumes enter the system through an upper ring-shaped manifold where inlet flow control valves direct the air from the manifold to the

energy recovery stoneware beds. Fumes, progressively heated as they pass through the hot stoneware bed, move toward the incineration chamber. Upon leaving the stoneware beds, the fumes are very close to the incineration temperature. Oxidation is completed in the gas-fired central chamber which is maintained at 1500°F. VOCs, present in the fumes, autoignite while still in the stoneware beds which reduces auxiliary fuel requirements. When the incoming air contains enough VOCs, the energy released will provide enough heat to support the inner chamber ignition, allowing the burner to switch automatically to pilot mode. The purified air is then pulled from the central chamber through the stoneware beds and exits through the outlet control valves. The stoneware beds absorb the heat. The cooled air then exits to the exhaust fan at a temperature only slightly higher than that of the incoming air. Subsequently, the direction of flow reverses, the energy stored in the stoneware now preheats the incoming batch of air, and the inlet stoneware bed becomes the outlet stoneware bed.

Results

The VOC Abatement system's action is continuous cycling by taking advantage of the use and reuse of the heat energy stored in ceramic stoneware beds. With its high surface area for heat transfer and mass for energy retention, the stoneware beds' size and shape assure excellent air flow around, over, and under every element.

Polaroid's VOC Abatement system is virtually indestructible and has required minimal upkeep maintenance since its installation (only the valves have been redesigned). The system can receive more than 75,000 standard cubic feet of process exhaust streams per minute; destroy 2,800 tons of VOCs per year; produce a destruction efficiency greater than 98%; achieve a thermal efficiency greater than 95%; and operate in temperatures up to 1800°F. The 1996 annual operating cost of the VOC Abatement system was $500,000, including $45,000 for natural gas.

Beyond Environmental Compliance

Background

The environmentally-volatile era of the 1980s challenged Polaroid to comply with the numerous federal, state, and local regulatory requirements. Polaroid implemented compliance programs to reduce the potential liability associated with environmental non-compliance, while the company's drive for excellence in environmental stewardship led to the development of an internal pollution prevention program, the Toxic Use and Waste Reduction (TUWR) program, which went beyond compliance requirements.

In support of the TUWR program, a centralized measuring system called Environmental Accounting and Reporting System (EARS) was developed in 1987, using 1988 as the baseline, to integrate data collection throughout the corporate structure. EARS monitors and reports the rates of toxic use and waste generation for chemical materials (Categories I through V — refer to abstract on Establishment of Chemical Categories). In addition, EARS measures waste reduction per unit of production which is also the basis for the Massachusetts Toxic Use Reduction Act (MATURA), enacted in 1989. This calculation method normalizes the performance measurement and is relatively unaffected by changes in production volume. Environmental credits can be obtained through waste reduction efforts in all material categories and by reducing the use of Category I and II materials. These environmental credits are awarded to corporate divisions for achieving or exceeding TUWR goals.

Description

Data collected in 1988 was used to establish the baseline under EARS for all categories in measuring toxic use and waste reduction per unit production. The 1988 totals were defined as 100% of the baseline amount (i.e., 1.00). A target goal of 10% reduction per year per unit of product was then set using the baseline measurement. Within the first five years, Polaroid achieved a corporate-wide reduction of greater than two million pounds per year of usage/waste which translates to an overall reduction of nearly 25%.

Results

In 1994, TUWR/EARS were expanded to include, among other aspects, energy reduction and water conservation. The systems' natural progression has also resulted in another expansion which provides data collections and reporting for the Superfund Amendment and Reauthorization Act via the Toxic Release Inventory's Form Rs and MATURA.

Indoor Air Quality Management

Background

Polaroid started its Indoor Air Quality (IAQ) program in 1987 and is taking an increasingly proactive approach to IAQ. Over the years, Polaroid has performed more than 29 separate investigations and studies at 17 different locations.

Description

Since 1996, Polaroid has conducted 10 proactive IAQ investigations and studies. These studies involve sampling and testing the air inside buildings for volatile organic compounds, carbon dioxide levels, dust, bacteria count, relative humidity, and temperature. Polaroid performed the sampling over a four-hour period during the middle of a normal workday. Figure 2-5 shows the results from various facilities. Sampling methods include carbontrap activated charcoal tubes for volatile organic compounds; AQ502 for carbon dioxide, temperature, and relative humidity; and DATARAM for particulate matter (dust). All results of the studies were within the American Society of Heating, Refrigeration, and Air conditioning Engineers (ASHRAE) Guidelines. Polaroid plans to continue proactive routine IAQ studies throughout the corporation.

Results

By using a proactive approach for its IAQ program, Polaroid has improved the working environment for its employees. Employee satisfaction and trust have also improved making the workplace more enjoyable, increasing production, and improving product quality.

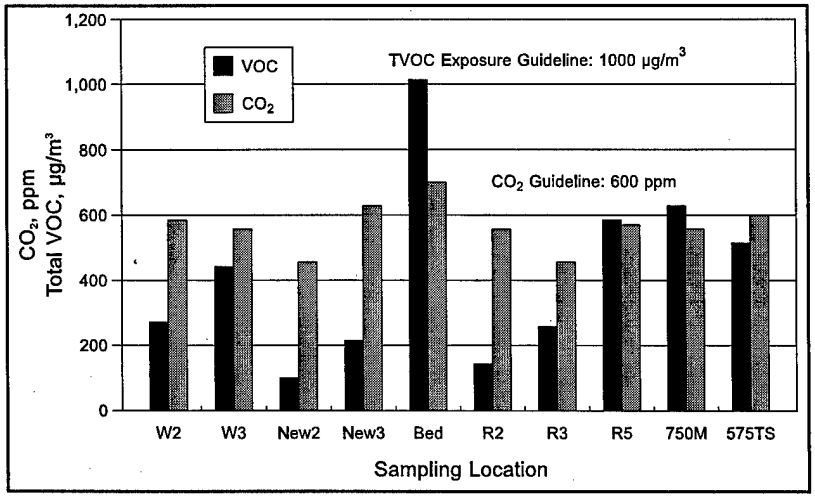

Figure 2-5. Carbon Dioxide and Total Volatile Organic Compound Concentrations

Rockwell Avionics & Communications - Cedar Rapids, IA

On Line PWB Manual

Background

The Advanced Engineering and Core Design Process (AE&CDP) Group at CACD has developed a paperless design tool to help engineers transition designs into hardware. Historically, PWB design, layout, and process information was maintained in hard-copy manuals, data books, or the process owner's memory. No single engineer had copies of all the manuals or information needed and if so, the data was most likely obsolete.

Description

The AE&CDP took advantage of a commercial-off-the-shelf software package to compose an easily distributable, paperless manual. It provides information and guidance on PWB processes, materials and properties, device footprints, workstation library data, design and layout guidelines and rules, and lessons learned.

Results

Developing this on-line PWB manual ensures that all designers and engineers use the same technology, design rules and that any added features or changes can have instant distribution. The manual is a living document accessible from PCs and workstations.

Sandia National Laboratories - Albuquerque, NM

DOE/DOD Environmental Data Bank

Background

As the responsible agent for the nation's nuclear weapon stockpile, Sandia National Laboratories' (SNL) Environments Engineering Group maintains the Department of Energy (DOE)/Department of Defense (DOD) Environmental Data Bank. This data bank contains information on identification and quantification of environments the weapons are expected to withstand.

Description

The data bank contains information on specific environments encountered during normal conditions such as transportation, handling, and storage; abnormal conditions such as fire, lightning and impact; and environmental conditions such as chemical, humidity and pressure. The bulk of this information is stored on physical media such as paper and microfiche and is susceptible to deterioration. Computer storage has only recently become an economical option for data to be placed, stored, and maintained electronically through a program called SPEEDI II. When the data is available online, it allows for improved alternatives such as test selection. Actual test data and test reports can also be included.

Other related efforts maintained by the Environments Engineering Group include the LUGSAN II. LUGSAN II is an aircraft compatibility environments analysis package which can perform lug and sway brace analysis calculations for the designer. The designer may input various aircraft, rack designs, maneuvers and hardware, and the system will perform rigid-body analysis to determine the loads to which the weapon will be subjected.

Results

SNL estimates that the program alone has reduced turnaround time on this type of analysis from two weeks to one day. SNL anticipates making this program available to the aircraft manufacturing industry someday.

In addition, the Aging Aircraft Specimen Library Database will be a database to allow a user to point and click on a particular aircraft section for information on all inspection results, Federal Aviation Administration (FAA) regulations pertaining to that part, and any problems associated with that area. SNL maintains that the structure of this database could be directly applicable to other industries such as medicine.

Environment, Safety, & Health Regulation Compliance Support for Suppliers

Background

Prior to initiating the present process, there existed no mechanism in place to address potential liability resulting from Environment, Safety, & Health (ES&H) regulatory compliance deficiencies of suppliers. Other companies used audits to manage this problem, but Sandia wanted to find an alternative to the adversarial nature of audits and manage exposure to liability in a positive and productive way. The process was also developed as a way to manage the risk of cost or schedule overruns due to regulatory compliance issues.

Description

Sandia has developed a database/knowledge-based system to perform environment, safety, and health regulatory compliance assessments of manufacturing processes. It is part of Sandia's aggressive, proactive approach to managing the exposure to risk and liability resulting from supplier ES&H regulatory compliance deficiencies, particularly in hazardous waste management and disposal. The process investigates, identifies, and communicates all known or suspected hazards related to contracted activities. It also identifies ES&H technical assistance or other intervention strategies that result in win-win solutions for Sandia and its suppliers.

First, a process assessment methodology was developed, applied to contract specifications, and made available to suppliers. A database was established to link manufacturing processes and materials with regulatory issues. The database was enhanced to incorporate solutions to compliance issues including compliance program templates, environmentally conscious manufacturing technologies, pollution prevention and waste minimization, and federal, state, and local resources. The database was called Interactive Technology Distribution System (ITDS). A front end smart questionnaire called Materials and Process Characterization (MPC) questionnaire was developed and interfaced with the database using a commercially available software package called Exsys®. The result was an expert database/knowledge-based system called ITDS/MPC.

ITDS/MPC, which differs from commercially available regulatory databases in several ways, is ideal for aiding small businesses. It is designed for users not familiar with ES&H regulatory compliance issues. Users need not have any knowledge of regulations because regulatory issues are linked to materials and processes. Hazard determinations are made for the user based on regulatory criteria. Going from materials and processes to regulatory compliance issues frequently requires some professional judgement and interpretation. This expertise is contained in the knowledge-base of the MPC. ITDS/MPC teaches the user about regulatory compliance issues. MPC may also be used to model changes in regulatory compliance issues with changes or additions of new materials and processes.

Results

ITDS/MPC is a tool to assist the user in determining compliance requirements, prioritizing those issues, and solving compliance problems. It is also a training tool that is most useful to organizations without access to EH&S professionals.

The ITDS is built on a commercially available database platform (Paradox® for Windows) which operates in a DOS/Windows environment and may be networked. The MPC is built on a commercially available expert system shell (Exsys®) supporting both DOS/Windows and Macintosh operating systems. Minimum hardware requirements are IBM PC (or compatible), 4 MB RAM, 80 MB hard disk space.

Application of this process and automated tools have helped Sandia improve relationships with its suppliers, especially the small industrial manufacturers. The system identifies potential regulatory issues early, particularly those which vary from state to state, and avoids liability risks. It identifies cost effective solutions to regulatory problems and uses technology transfer to solve potential compliance problems.

Texas Instruments, DS&EG - Dallas, TX

Environmental Database System Timeline

Background

Texas Instruments (TI) DS&EG implemented their environmental database system (TIESYS) in 1990 in response to expanding government requirements in documentation on chemicals used by the company. TIESYS is an integrated database system that collects, tracks, and controls a variety of environmental data for supporting multidisciplinary record keeping requirements. It also provides manufacturing and support management with timely and accurate data for operations analysis. Prior to 1985, the record keeping requirements of chemicals used by industry were limited to the control of all chemicals imported and exported as required by the Toxic Substance Control Act of 1977. Since 1985, environmental laws have placed an additional burden on the record keeping functions of industry such as:

- Knowledge of all chemicals in the plant (OSHA, 1985)
- Volumes and locations of chemical use (Superfund Amendment Reauthorization Act 311/312/313/, 1986)
- Mass balance/chemicals at process versus fate (Superfund Amendment Reauthorization Act 313, 1986)
- Document process throughput and improvements (Pollution Prevention Act, 1990)
- Know chemicals and quantities in emissions and stacks (Clean Air Act Amendment, 1990).

Description

In 1990, TI DS&EG analyzed the condition of their environmental database system and concluded that they were no longer effectively managing the necessary operational tasks to meet the dynamic regulatory climate, increasing customer requirements, and quality issues. Therefore they initiated the TIESYS Project in March 1990.

The first phase of the project included forming a committee, generating requirements specifications, conducting a market analysis, interviews and plant visits, and purchasing Flow Gemini software from General Resource Corporation, Santa Barbara, CA. The second phase started in January 1991 with implementation of a pilot project at TI DS&EG's Lewisville, TX site. The Flow Gemini's System Interface was assembled and the Chemtrak package was developed in-house. The Inventory and Chemical Information Systems were available off the shelf.

Results

TI DS&EG has realized a number of achievements including the ability to track chemical use down to the process level; ability to store data on products and ingredients; ability to compile data on all products; ability to establish on-site quantities; and the ability to compile and produce reports such as SARA 311/312. Although these achievements of the DS&EG database system are common among chemical manufacturing industries, it is unique among the chemical user industries and has generated a considerable interest from other industries.

With the success demonstrated on the pilot project, the next phases of the project will include migrating the system to a mainframe in January 1992 and fan out to other sites throughout 1992 and 1993.

U.S. Army Combat Systems Test Activity (Aberdeen Test Center) - Aberdeen, MD

Environmental Noise Management Program

Background

Since 1984, Combat Systems Test Activity (CSTA) has instituted several operational initiatives to reduce environmental noise impact to surrounding communities and to better balance CSTA's mission with community concerns. Before that time, predicting or assessing noise propagation was not conducted because of the tedious mathematical computations required and the lack of adequate weather data. A primitive warning system with a limited number of sensors around the Proving Ground proved inadequate.

Description

A computerized modeling program, developed to predict noise propagation in 1988 by the University of Dayton and the Atmospheric Sciences Laboratory, was installed at CSTA. The program accounted for meteorological factors that affected noise propagation such as air density, temperature inversions, and wind speed and direction. The meteorological measurements needed to predict noise propagation included surface wind and temperature, and wind and temperature aloft which CSTA has the capability to measure with sensitive ground and airborne sensors. The Noise Model used this meteorological data with the charge weight and firing site to produce a decibel (dB) contour level map for the noise distribution prediction.

Results

CSTA has also installed an updated noise monitoring system. The original system consisted of four monitors developed in 1984 by Construction Engineering Research Laboratory. The upgrade—started in 1991—has added 14 Larson Davis Laboratories monitors with plans to order additional units as funding becomes available. The monitors, stationed around CSTA, automatically call in to the base station computer. The data collected is used to verify and update the noise prediction model, respond to noise complaints, and investigate damage claims.

CSTA conducts a daily noise assessment each morning large caliber firings are scheduled. Weather data is collected and used to generate a predicted noise contour plot for the surrounding area. To validate the model for that particular day, a three-pound charge is detonated and the noise levels in the surrounding communities are measured. Based on these confirmed predicted/monitored levels, appropriate restrictions are implemented. If the predicted noise level is above 130 dB, the firing is postponed, to be resumed by command decision. In the range of 125 dB to 130 dB, the firing is evaluated on a case-by-case basis with approval by the Executive Officer or his designee.

No firings or detonations of any type are conducted weekdays before 6:00 AM and after 10:00 PM; Saturdays before 7:30 AM and after 3:30 PM; and Sundays and holidays. No large caliber firings and no static detonations of five pounds or more are conducted weekdays before 8:30 AM and after 10:00 PM, and Saturdays before 8:30 AM and after 3:30 PM. The CSTA commander must approve all other firings.


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Section 3

Environmentally Conscious Manufacturing

Introduction

Environmentally conscious manufacturing is defined as the use of the most efficient processes and practices possible to transform process inputs, such as energy, materials, etc., into a product that meets all germane specification, with a minimum of waste or waste by-products. Environmentally conscious manufacturing operations use a minimum of raw material and energy to manufacture products.

Does your company need help in evaluating its manufacturing processes and practices? The key phrase is environmental efficiency — a ranking of key factors in manufacturing that accomplishes the same purpose and achieves the desired objective with minimal impact on the environment.

As a minimum, the following factors must be considered when determining your company's relative environmental efficiency:

- Quantity of raw materials required per unit for a final product
- Energy required to produce a product
- Hazards from any waste generated during the manufacturing process
- Work materials sacrificed by the process

The ultimate goal of environmentally conscious manufacturing is sustainable development. We must look to the future and start developing new ways to manufacture products that meet our present needs without compromising future generations' ability to meet their own needs. To achieve this goal, companies must change their present methods of doing business and look for solutions that will lead them toward the goal of sustainable development. The following section contains quality examples of environmentally conscious manufacturing practices.

Bell Helicopter Textron, Inc. - Fort Worth, TX

Paint and Paint Gun Improvements

Background

The challenge was to comply with air regulations in the State of Texas in a non-attainment area. In order to comply, an Alternate Reasonably Available Control Technology (ARACT) was developed.

Description

This committed Bell Helicopter Textron, Inc. (BHTI) to using High Volume Low Pressure (HVLP) paint guns. Additionally, paint improvements were completed in 1995 when Bell changed from high solvent paint to a high solid formula that required less solvent.

Results

As a result of the paint gun installation and the new high solids paint, Bell reduced paint consumption by 15%. The cost of implementation is far outweighed by the compliance factor and reduced paint usage, thus air emissions.

Another waste reduction effort was to install plural component paint mixing systems. This system is used with multi-part paint. The objective is to mix the paint to the proper consistency just prior to spraying. After the paint gun is used, the nozzle is purged with solvent to clean the gun before the paint dries. This system has helped BHTI to reduce solvent usage and paint waste. Less material usage and lower waste disposal cost are the savings realized.

City of Chattanooga - Chattanooga, TN

CARTA/Electric Buses

Background

When the City of Chattanooga realized that traffic and parking would pose major problems with the revitalization of the downtown area and the opening of the Tennessee Aquarium, it decided to investigate the feasibility of electric buses. Although the City had considered trolley cars, diesel powered buses, and other alternatives, it wanted to support environmental efforts and avoid drawbacks associated with the other options.

Chattanooga enlisted a local retired manufacturing executive to perform the feasibility study, and he examined systems in California, England, and Switzerland. Santa Barbara, California was using electric buses; however, they would not perform well in Chattanooga because of significant differences in terrain. England and Switzerland were

investigated because of the technologies being used to develop electric buses. Although the technology was available, no one could develop buses with the proper characteristics for use in Chattanooga.

Description

Two buses developed using a new technology were made by a company in California. After initial operation, several changes were necessary, and the retired executive developed a new design incorporating an inventive, lightweight frame design and other weight saving features. The buses were built in Chattanooga.

The City contracts for two buses at a time, and the City participates with the manufacturer, Advanced Vehicle Systems, on the design team. New features and designs have been incorporated to enhance the operation with each contract; for example, changes have been made from DC motors to AC motors to provide more horsepower with the same range. Other changes under investigation include changing to a low voltage motor and incorporating a high efficiency air conditioning system.

Results

The City is a test bed for the new designs where changes can be proven under actual operation, and there is a Tennessee Valley Authority (TVA) test track nearby. The buses have been incorporated into 15 different cities, and by late 1996, Chattanooga will have 20 buses in operation. At the height of tourist season, up to 7,000 passengers per day ride the nine buses currently in use. Because the City constructed parking garages for patrons to leave cars, there is no fee to ride the buses. The operating funds for the buses come from the parking garage charges.

Sustainable Development

Background

An evolutionary initiative begun in the late 1960s helped guide Chattanooga from a city addressing specific problems to one with an infusive vision of sustainable development and growth. Responding to a U.S. Health, Education and Welfare designation as the worst polluted city in the country in 1969, Chattanooga made a commitment to transform the City's reputation by first confronting independent issues. In time, those issues became interdependent and subsequently evolved into a collection of community projects that improved Chattanooga's quality of life. Specific issues of address included industrial pollution, fair and better housing, downtown transportation enhancement, clean-up of the river, business development, cultural facilities, and disabled adult workers. Chattanooga maintains that sustainable development has best been defined as a way to implement economic development while saving natural resources and respecting environmental concerns.

Description

One example of this commitment was the reconnection to the Tennessee River that runs through the City and that has long been considered its lifeblood. To that end, the Tennessee Aquarium was constructed — providing an unanticipated appeal for students, researchers and visitors and attracting more than *one million visitors* in its first six months of operation. It generated $133M in documented economic activity from an initial, private investment of $45M. The condemned Walnut Street Bridge was also restored and developed into a park-like pedestrian bridge spanning the river with aesthetically landscaped walkways and parks along the riverbanks. This bridge provided easy access to downtown businesses, shops, restaurants and museums.

Community leaders also emphasized inner-city issues related to housing and neighborhood improvements as well as development of new business incubation facilities. Projects were planned with input from the community through town meetings and were implemented with cooperation from City, county, federal, civic, and industrial organizations. The catalyst for initiating many project activities came from foundation grants, donated facilities, benchmarking community problems against other communities having similar problems, and creative problem solving.

Results

The City keeps initiatives energized by combining clusters of problems and taking advantage of federal grants, private donations, and revenues from tax referendums that are considered community investments. Sustainable development and growth is an ongoing, work-in-process effort that is gaining support from the local manufacturing industry which constitutes 23% of Chattanooga's economic activity. It also continues through many community activities and projects including the Millennium III planning process. Millennium III is a community participation, goal-setting process that focuses on Chattanooga's social and economic needs and helps establish final goals and projects for the 21st century.

Dayton Parts, Inc. - Harrisburg, PA

Spring Coating Environmental Requirements

Background

As the result of the Pennsylvania Department of Environmental Regulations (PaDER) provisions of the Federal Clean Air Act Standards, Dayton Parts, Inc. (DPI) determined that two different coatings used on assembled springs were non-compliant. The coatings—one a black, tar-based coating for multi-leaf springs and the other, a zinc-based coating for tapered springs—contained excessive Volatile Organic Compounds (VOCs) for meeting the new PaDER requirements. Faced with the expensive options of either purchasing equipment to capture VOCs or incurring progressive fines, DPI took steps to identify, test, and utilize new coating materials that would fully meet the new environmental standards. This requirement for identifying new coating materials with acceptable levels of VOCs was complicated by additional needs to meet salt spray tests, application-ease requirements, and simple part preparation, in addition to presenting a satisfactory finished appearance. The time available to find a solution was also limited by the regulating agency.

Description

To meet these requirements, DPI formed a Project Task Team with representation from the plant's production, manufacturing engineering, maintenance, purchasing and product engineering elements. The team developed solution parameters which included the range of environmental concerns (PaDER regulations, employee exposure, and waste disposal issues), quality issues, process capacity, and projected costs in addition to the time deadlines. Discussions were held with numerous paint manufacturers regarding the coating needs and revealed a concurrent requirement that thorough pre-application cleaning was a specification included with many of the suggested materials. After investigating cleaning methods, the team determined it should avoid coatings with pre-cleaning requirements if possible because of potentially high added costs and the environmental/safety problem associated with many cleaning methods.

A number of sample products were obtained from paint manufacturers and all were submitted to salt spray testing durations compatible with the quality requirements of DPI. Paints passing the first salt spray tests were subjected to additional similar tests as well as ASTM-specified tests (hardness, chip resistance, and adhesion) where applicable. The results of these tests—together with application methodologies and costs considerations—prompted the team to recommend a water soluble alkyd-based paint as a replacement for the black coating and a water-based, high performance vinyl coating as a replacement for the zinc-based coating. Neither required a pre-application cleaning of spring assemblies.

Results

DPI, through successful team investigation, has found replacement coatings for both product lines that exceed environmental VOC requirements and require no pre-application cleaning. Implementation is ahead of the PaDER required timetable. Tests prove that both replacement coatings may be applied using the cost-effective method of dipping, and then air drying. This application method will eliminate over 90% of the labor required for the replaced zinc-based coating. Implementing the replacement coatings saved over $500K compared to adding environmental control equipment to original processes.

Defense Contract Management Command - Ft Belvoir, VA

Eliminating Hazardous Materials from DOD Contracts and Weapons Systems

The Challenge

Eliminating hazardous materials from DOD contracts and weapons systems by promoting partnerships among the Services and their Contractors.

Historically, recommendations by contractors for using alternatives to hazardous materials on government contracts resulted in repeated testing by individual defense and contractor program managers, so all parties could gain their own confidence in the performance of the alternatives being considered. More often than not, alternatives were never accepted or agreed upon by the parties involved using this approach. As a result, DOD and the industrial base duplicated efforts and paid multiple times for qualification of the same alternatives for commonly shared processes, with little or no success to show for it. Then in early 1994, defense industry contractors, weapons systems program mangers, and various DOD/Industry conference attendees (CEOs and Corporate Presidents) expressed a need for "jointness" to address common

pollution prevention issues. Toward that end, a Secretary of Defense Memorandum, dated August 11, 1994, set requirements for cooperation of the Military Departments, Defense Agencies, and industry to work in unison to reduce duplication of effort in addressing pollution prevention opportunities. All were facing the same pressure for change.

Despite this history, impediments have remained to overcoming duplication of efforts in qualifying alternatives to hazardous material processes, changing military specifications/standards, budgeting enough money, qualifying tests for alternatives, and prioritizing approaches. To overcome these impediments the JG-APP was established by the Joint Logistics Commanders (JLC), on September 15, 1994 to focus on pollution prevention at sources (e.g., contractor plants). The joint group, consisting of representatives from each of the services, plus Defense Logistics Agency (Defense Contract Management Command), has focused on single contractor sites where they have found: (1) opportunities to minimize efforts in the identification of shared processes across multiple service programs; (2) opportunities for modification of designs, to influence future plans; and (3) chances to implement technically acceptable alternatives. Execution of the JG-APP's methodology entails identification of shared processes and applications, establishment of common test protocols, and joint coordination of alternative acceptance and implementation. The JG-APP methodology is complemented by the Single Process (Block Change) Initiative to facilitate quick, economical changes to contracts for qualified alternatives/processes. The JG-APP initiative also bridges manufacturing and sustaining (e.g., depots, et al maintenance facilities) logistics pollution prevention efforts with the Joint Depot Environmental Panel, another JLC group, established to focus on the needs of the depot community. This ensures a two-way communication of successes and lessons learned between contractor manufacturing activities and defense maintenance communities. Successes are also shared throughout private industry.

Methods

The JG-APP began methodology validation with selection of seven pilot sites having multi-service, multi-program manufacturing processes. Participating in the initiatives are McDonnell Douglas, Lockheed Martin, Pratt & Whitney, Texas Instruments-Defense Group, Hughes Missile Systems, Boeing Defense Systems, and General Electric Aircraft Engines. The methodology consists of 16 steps: identify players, list potential contractors, determine interest in the program, develop teaming agreements, identify target chemical/processes, identify alternatives, down-select alternatives, define Joint Test Protocol, implement JTP elements, formulate contractor implementation plan, conduct pilot tasks and estimate funding requirements, develop a business strategy, conduct and pay for validation testing, analyze data and implement, report on validation process, use report to create a Concept Paper for SPI (Acquisition Reform initiatives), and assure continuous process improvement. Products developed using JG-APP methodology are made available for use by government and industry. The tenant of the joint service partnership with industry is quite simple: there are no proprietary interests with respect to pollution prevention opportunities once an agreement is reached regarding the qualifications of alternatives. Technology transfer throughout Government and industry, even among competitors, is accomplished in this manner (also see http://www.jgapp.com).

Results (Current Status and Benefits)

JG-APP has seen big successes in 1996. Using the JG-APP methodology, Texas Instruments (TI) was the first pilot site to achieve a Block Change (April) through the SPI phase. This success at TI reduces annual VOC emissions by 40-80%, or 2,880 fewer pounds of VOCs, 3,000 fewer pounds of waste solvent and paint, and 300 fewer gallons of paint thinner; and at McDonnell Douglas, a cost avoidance of $6.25M from the reduction in the duplication of alternative qualification testing has been realized. As of April 1996, the initiative has documented a total of $12M in cost avoidance in qualification testing and alternative implementation. At the other pilot sites, JG-APP is seeing alternative testing to substitute various hazardous materials used in various systems. At Boeing, the emphasis is on replacing chrome, nickel, and cadmium. Unlike the other pilot sites, Boeing is focusing on pollution prevention across its entire industrial base and not just the immediate contractor site (Seattle in this case). At General Electric, where they have facilitated the Propulsion Environmental Working Group (includes Pratt & Whitney, Allison, Williams, Allied Signal, et al power plant manufacturers), the use of lead as a dry-film lubricant for jet engines is being explored. At Pratt & Whitney, chromated primer replacements were chosen for study. At Lockheed Martin, three pollution prevention opportunities were selected: replacement of zinc chromate primers; reduction of high VOC topcoats; and elimination of ink stenciling. The first two are

being leveraged at two other pilot sites, TI and Hughes. At Hughes, the tests focus on eliminating chromium as used in conversion coating. At TI, low/no VOC primers and topcoats to replace high VOC counterparts is the emphasis. McDonnell Douglas is testing chromate primers used on the aircraft exterior surfaces. The testing at McDonnell Douglas will extend over two years, to include lab and field phases. In contrast, when field testing is not required, the total test period may be concluded in as few as four months.

Overall Costs

The JG-APP Advisory Board (JPPAB) has invested approximately 3.4 man years into the pilot phase of the initiative during 1995 and 1996, plus $1.885 million for engineering and technical support provided by the National Defense Center for Environmental Excellence, and approximately $200,000 over two years for temporary duty assignment expenses (travel, per diem, etc.). The service and contractor participants, together, spent an average $275-300,000 per site to test the various alternatives.

JG-APP Organization

Representatives from each of the services plus Defense Contract Management Command (DCMC). JG-APP principal/JPPAB counterpart (below).

USAF:	BG Clyde M. Bolton Jr, Chairman JG-APP Robert Hill, Chairman JPPAB
USA:	MG Roy E. Beauchamp Luis Garcia-Baco
USN:	RADM L.F. Schriefer David Asiello
USMC:	MG Williams George Georgeadis
DCMC:	MG Robert W. Drewes A. Ken Siler

Department of Energy, Oak Ridge Operations - Oak Ridge, TN

Recycling Chemicals Used in Electroless Plating

Background

Because nickel coating improves corrosion resistance, surface luster, reflectivity, hardness, and wear resistance, many consumer and industrial products are protected by a layer of nickel. Unfortunately, the process of nickel plating generates large amounts of waste which is both hazardous and expensive to handle.

Description

Technology known as ENVIRO-CP has been developed which eliminates these problems. By simple and cost efficient technology, plating solutions from electroless nickel baths are not only treated to result in environmentally benign chemicals, but the nickel waste itself is rejuvenated and recycled. Because of the obvious advantages of the Electroless Plating Recycling System, Oak Ridge has licensed the process and is in the process of commercializing it.

Results

An additional benefit of this process is that it may be extended to other plating solutions with equal effectiveness. Use of this ENVIRO-CP has the potential of saving the plating industry billions of dollars in energy and disposal costs.

Digital Equipment Corporation - Westfield, MA

Painting/EPA and State Regulations

Background

Digital Equipment Corporation (DEC) Enclosures improved its paint and waste operation in the production shop by installing an automated painting system. The previous four-booth, three-shift operation evolved to an eight-booth, one-shift operation while meeting EPA and state regulations. DEC reduced the volatile organic compound (VOC) emissions while increasing production line capacity.

Description

Using the new system, the enamel painting (high solid paint) is conducted in the booths presented in Figure 3-1: (1-2 bell system), (3-4 electrostatic), (5-6 manual touch-up), and (7-8 robotic texturing). High quality parts are produced while cutting

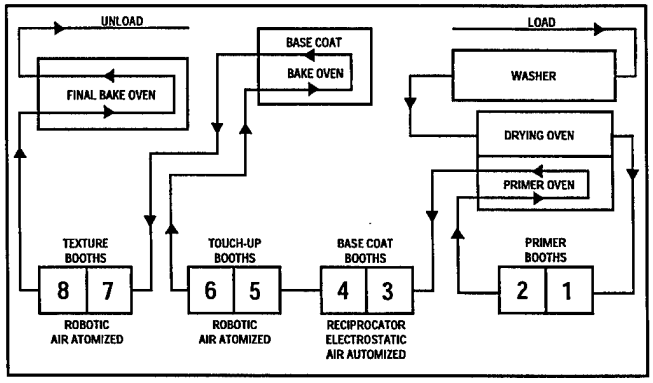


Figure 3-1. New Paint Line Schematic

paint consumption to a minimum. The process requires two hours for a complete cycle of the overhead conveyor, and employees are not required to wear painting masks.

Results

Paint sludge is dewatered using centrifuges. This process is the most effective means of monitoring and controlling the paint solid waste. The EPA and state regulations allow DEC 100 tons of VOC emissions per year. Since the new paint system has been installed, VOC emissions have been reduced from 77 tons to 14 tons per year. The sludge is then biologically treated by Laidlaw Environmental and safely disposed of, reducing disposal cost by $400 per drum.

The DEC waste water treatment system is monitored by the Automated Industrial Monitoring (AIM) security system which monitors the pH in waste water. The AIM system layers over the Allen Bradley Paint Line control system to interface DEC-developed software to distribute alarms to various stations and through E-Mail to key personnel. The system also automatically dispenses acid or base to balance waste water pH within the acceptable range. Alarm distribution is tailored to the needs of individual monitoring stations. The DEC facility is audited twice a year to ensure that the environmental standards are met.

Dover Air Force Base - Dover, DE

Volatile Organic Compounds Release Reduction

Background

Dover Air Force Base (DAFB) is in a severe Non-Attainment Area for ozone. The primary air pollutants of concern are volatile organic compounds (VOC) and nitrogen oxides (NO_x). Refueling activities of C-5 Galaxy aircraft resulted in sizable releases of VOCs. The old central heating plant was a prime culprit for releases of NO_x and other air pollutants. The replacement of the burners to low NO_x burners was required under the new regulations. The base has three vehicle refueling stations. One had a monthly volume of 10,000 gallons or more of fuel, and installation of vapor recovery equipment was required.

Description

The first effort to meet the new standards for air emissions was to change the fuel used in the C-5s. The aircraft were formerly fueled with JP-4 fuel, which is like a mixture of kerosene and aircraft gasoline. The use of this fuel results in substantial quantities of VOCs, including benzene, toluene, ethylbenzene, and xylene (BTEX). The new fuel, JP-8, has virtually no BTEX and results in low levels of VOC releases during refueling. This reduced VOC emissions by 145 tons per year.

The next effort was to convert the central heating plant to burn natural gas rather than No. 6 fuel oil and base housing from No.2 fuel oil to natural gas. This reduced air pollutant releases from the central heating plant by over 312 tons per year, plus a small increment of VOCs. The conversion of base housing is also expected to reduce VOC emissions by about one ton per year and other emissions by over 90%. The installation of vapor recovery equipment at the three base vehicle refueling stations reduced VOC emissions by 15 tons per year.

Results

The conversion from JP-4 aircraft fuel to JP-8, the switch from No. 6 fuel oil to natural gas at the central base heating plant, and the installation of vapor recovery equipment at the base vehicle refueling stations are fully implemented. The conversion to natural gas from No.2 fuel oil in base housing is underway. The changes have reduced costs by over $100,000 per year.

Hamilton Standard Electronic Manufacturing Center - Farmington, CT

Environmental Program

Background

The Hamilton Standard Electronic Manufacturing Center (HSEMC) was faced with the need to maintain competitiveness in the increasing environmentally conscious marketplace. Keeping up with changing government regulations and promoting proper use and optimizing hazardous materials for the benefit of the community became increasingly important.

Description

An Environmental program was designed to address these issues and will be operated by the environmental department. The Farmington facility has its own environmental department (that is supported by a central department at the Windsor Locks facility) to address the environmental needs of the site. The department, consisting of four associates, is responsible for reviewing and approving environmental plans, policies, and programs for the facility, and it must approve the necessary human and financial resources to administer these programs. The

department provides direction to the environmental teams and creates and sustains interest and communication in environmental awareness throughout the building. The department must also check the progress and ensure the appropriate procedures and activities are in place to achieve and maintain compliance with current environmental regulations.

The department associates also provide guidance to the Environmental, Health, and Safety Team which consists of up to twelve members who are representative of the facility's population. There are also sub-teams that handle special tasks within the facility. These teams help to make associates conscious of environmental concerns.

The environmental department has established certain goals that extend beyond the necessary levels to achieve environmental compliance. For example, it is taking steps to reduce and prevent pollution including elimination, substitution, or optimization of hazardous materials. It is also a voluntary member of the Environmental Protection Agency program to reduce 17 hazardous chemicals by 33% from 1988 levels by 1992 and by 50% by 1995. The department is attempting to eliminate all ozone-depleting substances from the facility but has been hindered by old specifications which require the use of Freon. Freon usage has dropped from 116,000 pounds in 1990 to 50,900 in 1992 at HSEMC, and remained low in 1993, particularly after the installation of an alcohol-based, semi-aqueous cleaner.

Results

HSEMC's team approach has made environmental compliance every associate's responsibility. Associates are able to suggest design changes that eliminate or reduce hazardous materials, and the designers are able to use manufacturing inputs early in the design process.

Hamilton Standard has carefully considered the increasing need for environmentally conscious manufacturing. It has developed a program that reaches from upper management to every associate. This program considers the future and what is best for the company and the community.

Work Environment

Background

With knowledge that 75% of the required workforce in the year 2000 is already in place, HSEMC is developing an environment for associates to develop their capabilities. Thus a key factor in reducing cost to the customer.

Description

In the 1990s, the Hamilton Standard Electronic Manufacturing Center focuses on people, values, and their continued development as the most important force in the company. HSEMC's drive to enhance the culture and value system encompasses 10 major focal points (Figure 3-2). These principles include customer satisfaction (everyone is a shareholder); environmental (more can always be done); training to continually upgrade associate skills; diversity (every person is valued); career development to provide incentive, assistance, and support to facilitate individual development; ethics (winning with integrity intact); health and safety (the well being of the associates enhance the well-being of the business); open and participative communication; empowerment (responsibility and authority to determine how a task is to be done is delegated to the associates performing the task); and community involvement (each associate is a viable, contributing member of society).

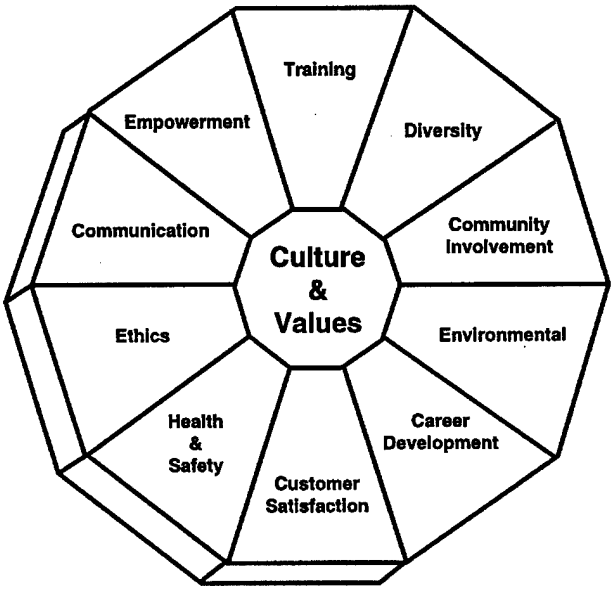


Figure 3-2. Work Environment

Results

This is a system of processes. Hamilton Standard realizes that communicating change is difficult — implementing change is more difficult — and that all walls must come down. Supportive management and ethics application are also critical factors. They cultivate change agents, and assume a solid and fundamental consistency of purpose. The company understands that to survive in the value-driven market of the 1990s, change is essential.

Kurt Manufacturing Company - Minneapolis, MN

Coolant Reclamation System

Background

Kurt adopted the use of a single water-based machining and grinding coolant throughout the company during 1990. This was implemented to pre-empt forth coming Environmental Protection Agency (EPA) regulations and to capitalize on cost savings through recycling. At that time, 13 different coolants were in use. To determine the coolant to use, a committee including supervisors, engineers, and the safety manager was formed and a design of experiments undertaken using the three most commonly used coolants. Kurt was searching for a coolant that would be: safe for operators to handle; compatible with all Kurt machining operations; repeatedly recyclable; and able to last three to four months without breaking down.

Description

After four months of testing and collecting data, it was determined that the coolant used did not matter — what mattered was the speed and feed of the machining and tools being used. W.R Grace Coolant Daracool 706LF (a synthetic) was selected as it was the least harmful to personnel in daily operations. The changeover to Daracool was challenging but by involving operators and supervisors in the process, the job was accomplished as a team effort.

Kurt also developed a method of reclaiming and recycling the coolant. The key element of the recycling system is the Sanborn Donaldson Patriot Recycler with its 500-gallon dirty tank and 500-gallon clean tank. This system was adapted and modified to meet the company's needs. A 500-gallon standby clean tank and 500-gallon standby dirty tank were added to the recycler. Attached to the standby dirty tank is a Spenser vacuum system connected throughout the main plant with two-inch PVC piping. To recover coolant, a reclaim operator connects a hose between the sump of a machine and the vacuum system piping. Fluid is pulled into the standby dirty tank. It is recycled through the Sanborn in 500-gallon baths. As the coolant is processed, it can be directed to any machining station in the plant through a 3/4-inch return line, and discharged into a clean holding tank for storage until required. Recycled and dirty coolant is transported to and from other plants in portable Tuff Tanks manufactured by Chemical Handling Equipment, Inc. of Waldbridge, Ohio. The recycler has also been modified to automatically monitor and control bacteria and pH of the coolant.

Results

The coolant change and recycle efforts have eliminated changing coolant every two to four weeks. Kurt has sustained enhanced machining results and has used the same coolant continuously for over one year to date. The additional prime benefit is the reduction of health hazards to employees.

Lockheed Martin Electronics and Missiles - Orlando, FL

Environmental Practices

Background

Lockheed Martin Electronics and Missiles designed the Pollution Prevention and Environmental Practices program to reduce pollution control costs and to comply with increasing pollution regulations. Lockheed Martin's Pollution Prevention and Environmental Practices constitute a strong environmental effort.

Description

The corporate philosophy of 100% compliance 100% of the time, and commitment of top management and employees have a significant impact on pollution prevention and control. As a part of the pollution prevention strategy, Lockheed implemented corporate-mandated programs, incorporated customer-specified programs, adapted existing cultural practices to requirements, re-engineered chemical inventory management, and created employee awareness. Lockheed also successfully participated in the following EPA voluntary programs:

- Green light relamping over a million square feet which yielded cost savings of over $25K per year;
- Energy conservation projects such as computer control of air conditioning and improved chiller cleaning and maintenance;
- 33/50 toxics reduction.

Results

Lockheed Martin has recently completed the design of the Chemical Inventory Management Program with procedures that require environmental, safety, and health approval and tracking numbers prior to order; re-engineer order/receiving and distribution systems; interface existing business software to an environmental information database; and create a state-of-the-art, cradle-to-grave tracking system.

Lockheed Martin Tactical Aircraft Systems - Fort Worth, TX

Hazardous Material Management

Background

In 1984, Lockheed Martin Tactical Aircraft Systems (LMTAS) adopted a corporate goal of zero discharge of hazardous waste. This effort was motivated by the high cost of compliance and liabilities with environmental regulations.

Description

A proactive formal emissions remediation management program was established using a team approach to achieve the zero discharge goal. Initial baselines were established and plans were developed for hazardous waste elimination and elimination of underground tanks. By 1987, goals and baselines were expanded to include a multimedia approach to pollution prevention. By 1988, an aggressive plan to reduce hazardous waste by 90% was well underway with 11 completed projects and 11 ongoing projects. The Air Force partnered with the company on facilities and research and development projects. In 1991, a formal Hazardous Material Management Program Office was established which adopted a goal-oriented approach to pollution prevention.

Metrics indicate progress in every major environmental area, and monthly and quarterly measurements are conducted with annual updates. The planning focus is on projects since projects can be tied to very specific goals.

Results

To date, more than 50 successful zero discharge projects have been completed. Examples of these projects include:

- Waterborne Primer (1985)
- High Energy Value Waste Segregation (1987)
- Ultrafiltration of Non-recyclable Coolant (1988)
- Mechanical Sealant Removal Process (1989)
- Non-halogenated Substitutes for "Safety Solvent" (1990)
- 47 Closed Systems for Paint Gun Cleaning (1991)
- Aqueous Degreaser (T-529 and T-530) (1992)
- Low Vapor Pressure Cleanup Solvents (1992)
- Reuse Hazardous Waste Drums (1993)
- Spent Lead-Acid Battery Recycling (1994)

Pollution prevention initiatives have saved more than $25 million on hazardous waste disposal alone (Table 3-1). LMTAS was selected from a field of 70 large technology companies to receive the Clean Texas 2000 1995 Governor's Award for Environmental Excellence.

Table 3-1. Pollution Prevention Results Through 1994

Result	Base Year
• 100% Reduction in PCB Devices	1984
• 98% Reduction in TRI Transfers	1987
• 98% Reduction in ODC Use	1987
• 96% Reduction in "EPA 17" Compounds	1988
• 96% Reduction in Effluent Heavy Metal Discharges	1987
• 100% Removal/Replacement of U/G Tanks	1984
• 85% Reduction in Hazardous & Manifested Waste	1984
• 85% Reduction in Reported Air Emissions	1987
• 60% Recycle of Nonhazardous Industrial Solid Waste	N/A
• 42% Reduction in NISW Disposal	1991
Savings of more than $25M on Hazardous waste disposal and $8M on wipe solvent alone!	

LMTAS continues to meet the environmental challenge by working with government and industry groups to help develop national environmental standards such as National Aerospace Standard 411, the National Emission Standards for Hazardous Air Pollutants, and Control Technology Guidelines. The company is also working with the DOD Joint Group for Acquisition Pollution Prevention. There are eight current projects and more than a dozen new projects planned. A decade of progress has produced major positive results and a strong team is in place and actively addressing remaining issues.

Elimination of Ozone-Depleting Compounds in F-16 Technical Orders

Background:

Technical Orders (T.O.s) are maintenance and repair instruction books for military weapon systems. They reference the use of products containing hazardous chemicals, many of which are ozone-depleting compounds (ODCs). Due to the 1996 phaseout of Class I ODCs, it became necessary to identify replacement products for those T.O. materials containing Class I ODCs. The study involved a review of each T.O. to identify all chemicals or chemical products, analysis of each product to find

the ones containing Class I ODCs, testing of candidates replacements, and incorporation of the verified replacements in the appropriate T.O.s.

Description:

Over two thousand Lockheed Martin-managed F-16 T.O.s were reviewed, leading to approximately 900 referenced chemicals. Of these products, 66 were found to contain one or more Class I ODCs. This encompassed a wide range of products, including release agents, adhesion promoters, antiseize compounds, circuit refrigerants, retaining compound primers, greases, corrosion preventive compounds, coatings, and cleaning solvents. Replacement candidates were identified on an application-by-application basis. In some cases, lab testing was performed. Others required only shop trials for verification, or were simply incorporated after a thorough engineering study of issues such as functionality, material compatibility, economics, and health/safety.

Results:

The replacements were incorporated into the T.O.s during 1996, and procurement data was provided to the inventory managers at applicable field units. The program was considered extremely successful, providing ODC-free maintenance and repair instructions for the 3,600-plus F-16s currently active in domestic bases as well as bases around the world.

Low Vapor Pressure Cleaning Solvent

Background

LMTAS has successfully implemented low vapor pressure solvent blends and a waste cloth management and disposal system in order to eliminate ozone depleting compound emissions in its wipe cleaning operations and still maintain low Volatile Organic Compound (VOC) emissions from its solvent cleaning operations.

Description

In September 1992, LMTAS replaced an 85% chlorofluorocarbon-113 (CFC-113), 15% VOC blend for wipe operations with a new low vapor pressure solvent and waste cloth management system, eliminating 200+ tons-per-year of CFC-113 emissions. Also, this implementation decreased VOC emissions; 1996 VOC emissions from cleaning solvents were only 1.9 tons-per-year. The same operations emitted ~45 tons-per-year of VOC and ~250 tons-per-year CFC-113 in the late 1980s.

Results

The low pressure solvent blends were selected after full-scale laboratory corrosion tests and cleaning performance tests. The solvents have been licensed to Dynamold Solvents and are sold to several aerospace and non-aerospace firms. Cost savings plus cost avoidance have been documented for $0.95 million for 1993 and $1.3 million for 1994. LMTAS management recently estimated the cost savings from the wipe solvent implementation to be $8.2 million for the five-year period of 1992 to 1997.

Five United States of America (USA) patents and three Taiwanese patents have been issued to LMTAS on the DS series solvent formulations and the waste cloth management system. More patent applications (USA and international) are either pending or are being reviewed by the Patent Office.

This technology represents the design of solvent blends that are less toxic than many of the alternatives previously being used, such as MEK (methyl ethyl ketone), TCA (1,1,1-trichloroethane), and various blends of toxic solvents. The reduced solvent usage and waste cloth management system makes the cleaning solvent "inherently safer with regard to accident potential." EPA has recognized this technology as having environmental benefits via several EPA Stratospheric Ozone Protection Awards in 1993 and a Certificate of Recognition for "Significant Reduction in Hazardous Air Pollutants," in 1994. EPA has additionally recognized that the "technology is applicable to industry and society" via the incentives/requirements to use this technology in the Aerospace National Emission Standard for Hazardous Air Pollutants (August 1995) and the draft Aerospace Control Technology Guide (July 1996).

Use and Verification of Aqueous Alkaline Cleaners

Background

LMTAS was the first aerospace company to implement innovative aqueous cleaning technology for cleaning tubing and honeycomb core. Tubing is used in the aerospace industry for transferring pressurized oxygen within an aerospace vehicle. Honeycomb core is used in the aerospace industry for producing bonded structural parts. Both applications require that the parts meet stringent cleanliness requirements. These requirements were previously met by using cold cleaning and/or vapor degreasing with chlorinated solvents. These solvents included 1,1,1-trichloroethane (TCA) and trichloroethylene (TCE). These chlorinated solvents are toxic, and TCA is an ozone depleting compound.

Description

The use of chlorinated solvents posed a threat to the environment because they were commonly released into the air during cleaning operations and because the likelihood of a spill during their use was significant.

Results

These solvents were successfully replaced with aqueous cleaning technology. Implementation of aqueous cleaning technology at LMTAS has eliminated approximately 360 tons of air emissions per year and has resulted in a cost savings of $490K per year. In addition to replacing chlorinated solvents with innovative aqueous cleaning technology, LMTAS has also explored the use of environmentally safe methods for quantifying surface contaminants on parts cleaned by various cleaning technologies. Traditionally, extraction with CFC-113 followed by gravimetric or FTIR analysis has been used for quantifying surface contaminants. The use of CFC-113 is undesirable due to its ozone depleting potential. LMTAS has demonstrated the usefulness of carbon dioxide coulometry for determining the amount of residue remaining on a surface after cleaning and has used this technique for comparing the cleaning effectiveness of various cleaning technologies.

Lockheed Martin Corporation received an EPA Stratospheric Ozone Protection Award for the adoption of aqueous cleaning technology for cleaning tubing.

In summary, replacements of chlorinated solvent cleaning operations with aqueous cleaning operations offer the following benefits:

1. A reduction in the toxicity of the cleaning compounds used.
2. A reduction in the real and potential threat to the environment.
3. A significant cost savings due to the lower disposal costs associated with aqueous cleaning agents.
4. The required cleanliness levels can be easily achieved with aqueous cleaning (as verified by chemical analysis and mechanical testing). Novel analytical methods for cleanliness were demonstrated that use no hazardous solvents.
5. The aqueous cleaning technology can be (and has been) readily transferred to other facilities and industry sectors.

Mason & Hanger Corporation - Pantex Plant - Amarillo, TX

Groundwater Monitoring Program

Background

Mason & Hanger Corporation (M&H) found that rapid purging of the well caused changes in the pH of the groundwater samples such that they were no longer representative of the actual groundwater values. M&H similarly found that the groundwater sample bottle must be filled in a particular manner in order to obtain repeatable data—seemingly insignificant items such as rapidly pouring the water sample into the bottle or wiping off the threads of the bottle can have a major impact on the quality of the groundwater sample and resulting data. For example, a 1991 set of total organic carbon data from a well (consisting of 4 data points) could be interpreted that the "correct" value was either 3 ppm or 15 ppm. A similar set of 1993 data following the improvement of the sampling process shows more consistency, with all values ranging between 1.0 ppm and 1.6 ppm.

As a result of the review of groundwater sampling practices, M&H has found that scrupulous care is required in all groundwater sampling actions, and that consistency in work patterns is critical.

Description

A M&H groundwater monitoring review resulted in M&H examining its processes for establishing

well locations, acquiring groundwater samples, and evaluating data from more than 30 wells located at Iowa Army Ammunition Plant (IAAP). As a result of the review, M&H corrected water table elevation data on several wells and installed additional wells where needed to monitor a landfill site. A critical benefit from the 1992 review of the groundwater monitoring program is the identification of improved processes for obtaining groundwater samples. Because the composition of the water in a well changes as it stands for months, the well must be purged and allowed to re-fill just prior to taking the groundwater sample.

Results

Detailed groundwater sample acquisition plans have been developed and are carefully followed to ensure high quality data that can then be used with confidence for monitoring and remediation purposes. M&H also realized a spillover benefit as a result of the groundwater sampling process improvements, as a better understanding of the importance of careful and repeatable techniques has also resulted in the improvement of other laboratory processes.

Sitewide Environmental Impact Statement

Background

Mason & Hanger - Pantex has taken a proactive approach to fulfilling its Sitewide Environmental Impact Statement (EIS) responsibilities by making information available to the public that is understandable, timely, and accurate. With a "They're Not Going to Come to You" attitude, Pantex has combined electronic and print media, public information sessions, speaker bureau activities, employee public speaking and media training, and media seminars to form a comprehensive program delivering the Pantex EIS message.

Description

Pantex began this effort by preparing and implementing a Stakeholder Involvement Plan. The EIS stakeholders were identified as government (federal, state and local entities), the media, adversary groups, community leaders, the educational community (students and teachers), and the general public. The Stakeholder Involvement Plan represented the initial step in activities designed to maximize public involvement in EIS. Pantex contacted landowners, interest groups, and state and local officials to apprise them of the EIS process and to publish a schedule of planned activities. Activities included establishing a 24-hour EIS information hotline to handle information and speaker requests. This step was followed by distributing brochures and a quarterly EIS newsletter. Pantex EIS team members appeared on radio and television talk shows, and they produced a video used at public meetings and speaker bureau events. This video was made available to Pantex employees and interested stakeholders.

An Information Fair was held in anticipation of the May 1995 DOE public (Scoping) meeting. The Fair provided exhibits and presentations on EIS topics such as radiation safety, groundwater and overflight issues, as well as opportunities for citizens to talk with Pantex technical staff about their EIS concerns and questions. Pantex found the Fair to be so successful and well received that it was repeated the following year and is now slated to be an annual event.

Following the Scoping meeting, Pantex continued its outreach and awareness activities through additional activities including:

1. a Cultural Resources Program to foster involvement of interested Native American tribes,
2. a downtown Pantex Information Office to provide information to city residents,
3. a children's video, coupled with Pantex EIS team presentations to public, private, and home school audiences,
4. an essay contest for students to write about "What I Learned at the Pantex Information Fair," (winners received a monetary prize and special plant tour),
5. a multimedia, touch screen kiosk information center about Pantex and EIS available to the public in high schools, malls, post offices and libraries, and a Pantex EIS Internet HomePage.

Results

All of these Pantex EIS activities demonstrate the aggressive and encompassing approach to meeting the company's National Environmental Protection Act responsibilities. Positive indicators of Pantex EIS success include its nomination in 1995 to receive the Secretary's Award, and an invitation to discuss the entire National Environmental Protection Act process at the Spectrum '96 International Meeting in which the program will be featured as a seminar.

McDonnell Douglas Aerospace - St. Louis, MO

Environmental Improvement Initiatives

Background

McDonnell Douglas Aerospace (MDA) (St.Louis) established the Environmental Assurance division to perform technical and business analyses for selecting the most cost-effective and lowest-risk compliance methods to meet environmental directives projected for the next seven years.

Description

The company is reducing its environmental impact by altering operations, some of which involve specific modifications to a single process or piece of manufacturing equipment, while others are broad, sweeping modifications to the daily corporate operations.

Results

To ensure that all perspectives are reflected, multidiscipline teams have been formed to perform an analysis on each environmental issue requiring action. These teams are chartered with specific boundaries and tasks assignments within the Environmental Assurance division.

The Directives Review Committee is a standing committee comprised of OSHA and environmental representatives who use a disciplined process to review and prioritize requirements. It reviews and maintains all environmental requirements (federal, state, and local environmental regulations, contractual stipulations, and corporate policies) in a corporate database. It then identifies required improvement initiatives and prioritizes the improvement initiatives.

The Technical Review Committee then performs business case analyses (options evaluations, risk assessments, and cost estimations) on the prioritized initiatives, selects a preferred option, develops an action plan for each initiative, incorporates the action plan into an Environmental Assurance strategic plan and forwards recommendations to the Executive Review Committee for further action.

The Executive Review Committee analyzes the Technical Review Committee recommendations, discusses alternatives, risks, and other topics; provides enlightenment on future corporate direction, initiatives and policies; and approves/disapproves the recommendations. At this point, corporate commitment for funding of the initiative is made.

Through this disciplined approach, MDA (St. Louis) has been able to implement the majority of environmental initiative projects at the lowest cost option. By doing so, it has been more proactive in the environmental compliance arena, and can maintain the affordability of its products.

Project Deployment: Technology Transition to Production

Background

Because current and future environmental regulations have an impact on manufacturing, MDA (St. Louis) devised a way to change production processes to comply with the regulations with the least amount of risk to the production programs.

Description

This was accomplished by using a multidiscipline team approach to generate solutions and determine their workability. These multidisciplined teams include all personnel affected by the new regulations. Customer concerns (internal and external) are taken into account, and all aspects of the current manufacturing method that would be affected are noted. Requirements for the replacement process are obtained using Quality Function Deployment (QFD), and the potential replacement processes are ranked using the QFD matrix.

When the leading candidates are identified, the team attempts to lower the risks of these methods even further by performing trials on non-production parts, running laboratory tests, or performing Taguchi testing. When the team agrees that the process is ready for production and meets the QFD requirements, shop trials begin on production parts. Shop trials are always required, even if the process is proven at other facilities, because each facility is unique.

Each affected process is tested, and each trial is supported by the team across all shifts. The process is monitored and corrective action taken until it meets all requirements and is production-ready. The team, or a third party, monitors the process performance to ensure project objectives have been met.

Results

This method has been used successfully on several programs, including ozone-depleting substance elimination and compliant coatings. Not only did the new processes not have an adverse impact on manufacturing, in some cases they produced im-

provements and cost savings. These improvements are highlighted by the following examples.

1. *Low Vapor Pressure Solvents.* MDA (St. Louis) began replacing trichloroethane (TCA) by establishing a natural work group comprised of people involved in operations that used TCA. This group selected several low vapor pressure solvents as replacements. Several were needed as no single solvent could be determined to duplicate all TCA's capabilities. However, these replacement solvents could be used at lower vapor pressures; they had slower evaporation rates resulting in a significant reduction in the required material; and approximately 70% less material was required as compared to TCA. These resulted in a cost impact of a 40% material cost saving or $14 per gallon.
2. *Non-destructive Testing.* The non-destructive testing penetrant developer used to detect cracks was changed in 1995 from an ODS to a non-ODS dry powder material. The annual cost of the ODS was $7.6K, and the estimated yearly cost of the dry powder was $1.4K, resulting in a year cost saving of approximately $6.2K.

Millar Western Pulp (Meadow Lake) Ltd. - Saskatchewan, Canada

Chemical Recycling

Background

Smelt (predominantly sodium carbonate) from Recovery Boiler is being landfilled. Opportunity exists, and is being actively explored, to convert the smelt to an alkali source for pulping/bleaching of woodfibre.

Results

Besides the environmental benefit of decreasing the amount of material being landfilled, recovery of the alkali would lead to reductions in the cost of manufacturing pulp as purchased caustic needs would decrease.

Air Pollution

Background

Although Millar Western meets all governmental regulations for air emissions, both gaseous and particulate, the company is striving to decrease emissions of both types of materials.

Description

Incineration of bark and waste fibre and wind action on electrostatic precipitator ash lead to particulate emissions, and anaerobic activity in its waste water holding pond results in the generation of malodorous compounds such as reduced sulphur species.

Results

Resolving these concerns will result in an environmental benefit of decreasing particulate and gaseous emissions, as well as enable the company to maintain harmonious relations with its neighbors.

Recycle of Recovery Boiler Smelt

Background

Millar Western is currently running a pilot plant to determine the feasibility of recycling the smelt from the Recovery Boiler for use as an alkali source in the pulp mill.

Results

Work to date has demonstrated the potential of replacing some of the purchased alkali (caustic) with recycled smelt.

Nascote Industries, Inc. - Nashville, IL

Paint Fumes Management

Background

When the company began operations, it received certification from the Illinois Environmental Protection Agency (IEPA) to operate its paint lines under the "small plant" classification that stipulated emissions of less than 249 tons per year of volatile organic compounds (VOCs) per coating line. Although extensions of operating certification were obtained that permitted the plant to operate through 1989, Nascote determined that installation of an abatement system would be necessary to meet IEPA requirements and to satisfy the EPA requirement to demonstrate best available control technology.

Description

Nascote installed a regenerative thermal oxidation system from the Salem Corporation to control VOC emissions from its paint lines due to escalating production levels.

The plant was designed to come up to full production in three stages, each stage to include additional pollution control equipment to comply with

the IEPA standards. Stage one consisted of thermal incineration of all bake oven air, and the following two stages included the abatement of spray booth exhaust as production levels increased. Production levels, however, increased more rapidly than expected, and Nascote began exceeding the VOC emission limits in early 1988, prematurely entering into stages two and three.

The regenerative thermal oxidation system from Salem Corporation is a regenerative system that reuses assets such as heat, energy, and pressure, which would otherwise be wasted. Regenerative thermal incineration destroys fume emissions and odors by effectively reusing the heat of combustion. This particular Salem Corporation system is a multi-chamber configuration that operates in an alternating inlet/outlet mode while the off-line chamber is purged of trapped contaminants. This feature ensures that all contaminants trapped in the matrix beds and retention areas are purged with clean air after each inlet cycle. Through this purging process and the high thermal efficiency (96%), up to 99% of all volatile organic compounds are destroyed.

Results

At Nascote, a $10 million investment in this system allowed the company to greatly exceed IEPA and EPA requirements, thereby avoiding potential bottlenecks in the future as production capacity increased, and ensuring environmentally responsible operations.

Naval Aviation Depot - Jacksonville, FL

Closed Loop Recycle Systems for Waste Minimization

Background

Naval Aviation Depot (NAVDEP)-Jacksonville, FL has integrated closed-loop water recycle systems into the electroplating and paint stripping operations, and has provisions for another at the aircraft painting and metal finishing operation. These systems, consisting of standard wastewater treatment unit operations, provide a unique system resulting in significant reduction in hazardous waste and water use while ensuring long term environmental compliance.

Description

The former existing wastewater treatment system included both an industrial wastewater treatment plant (IWTP) and domestic wastewater treatment plant (DWTP) in series. Effluent from the IWTP was reprocessed in the DWTP before discharge into the St. John's River. Sludge from both the IWTP and DWTP were characterized as hazardous waste.

Results

NADEP-Jacksonville, through an environmental initiative, developed and implemented plans for eliminating the wastewater discharge from the hazardous waste producing operations of electroplating, metal treatment and aircraft painting, and aircraft stripping and metal finishing. Closed loop recycle systems that process the rinse waters and return them to the operation were installed.

Currently the system for the electroplating shop is in operation. The system for the aircraft stripping and metal finishing is in trial, while the system for aircraft painting and metal treatment is in redesign. Implementing a closed loop recycle system attached to a specific operation allows the system to be tailored and discourages waste mixing.

Environmental Control Center

Background

NADEP-Jacksonville had problems handling hazardous material, hazardous waste, waste oil, and recyclables. A system existed in which individual material users were responsible for managing hazardous materials and hazardous waste including labeling, manifesting, and disposition. Some of these activities are regulatory requirements involving liability and potential penalties, which institutes JIT principles and a user-friendly system.

Description

The Environmental Control Center (ECC) is a centralized receiving and issue area for hazardous materials for the NADEP-Jacksonville shops. ECC personnel coordinate the procurement of hazardous materials in conjunction with the process users based on historical usage. The ECC receives hazardous material and delivers the material to the process site in the appropriate containers and controls the quantity of hazardous materials procured through facility-wide centralized screening of requisitions. This effort eliminated the autonomous purchase of hazardous materials by individual shops that frequently resulted in over-procurement due to numerous minimum quantity purchases being larger than the requirement. The ECC inspects

received materials for damage, expiration, and proper labeling.

The ECC is also the centralized pickup and dispositioner for hazardous waste for the shops. ECC personnel pick up hazardous waste in conjunction with the hazardous materials delivery service and manages the hazardous waste by consolidating like-wastes, inspecting for container damage, applying appropriate labeling, and manifesting and coordinating disposal.

Prior to the establishment of the ECC, individual material users were responsible for managing hazardous materials and hazardous wastes including labeling, manifesting, and disposition. Some of these activities are regulatory requirements involving liability and potential penalties. The ECC provides expertise to complete these steps, significantly reducing these issues. A user only has to call the ECC and request delivery or pick up of material. The ECC is also responsible for recyclable material pickup and disposition, and Material Safety Data Sheet's (MSDS) management.

As a centralized activity for both hazardous material and waste, the ECC has leveraged resources to more efficiently perform related activities. For example, the ECC hazardous materials inventory and hazardous waste tracking databases provide valuable information for reutilization of excess materials, improved procurement strategies, shelf-life determination and reporting, and monitoring satellite accumulation storage. In addition, a dedicated staff for the ECC can be effectively trained in accordance with regulations, thereby developing expertise in hazardous material and hazardous waste management.

Results

The ECC provides this service which has resulted in significant reduction in generated hazardous waste and hazardous materials inventory.

As a result of instituting the ECC, NADEP-Jacksonville has reduced the hazardous material procurement from $7 million in FY90 to $5.1 million in FY92, reduced hazardous material inventory on the shop floor from eight months to two weeks, and reduced municipal waste by 35%. Unquantifiable benefits include improved tracking of materials, improved security of materials, and leveraging of resources. The ECC annual recurring costs of operation are more than offset considering the easily quantified benefits alone.

Naval Surface Warfare Center, Crane Division - Crane, IN

Digital Photo Processing

Background

The Crane Naval Surface Warfare Center Photo lab introduced digital photo processing in 1996.

Description

This process eliminated five chemical processors and the use of 28 hazardous products associated with them. It is three times faster than the traditional method and will allow instantaneous electronic transmission of the photo images.

Results

A special digital still camera is used to take the shots and retain them on a memory card. Special software used in conjunction with a scanner, PC, enhanced video monitor and printer is used for image processing. This equipment costs about $190K and is expected to save $210K per year in labor and material acquisition and disposal costs. The new process eliminated the use of 88,000 lbs of chemicals and 500,000 gallons of water per year.

Powder Coating

Background

In 1996, Crane Naval Surface Warfare Center installed a powder coating system in its Small Arms Maintenance and Rework Facility to replace an existing spray painting operation. The process is being implemented at this current time.

Description

The coating operation involves the application of a dry resin powder to a clean metal object. Upon heating, the powder melts and imparts a very durable, highly protective coating to the metal.

Results

It enhances the quality and maintainability of the product while eliminating the generation of volatile organic compounds and hazardous waste during processing. The cost of the equipment and associated installation was about $400K. Approximately $190K per year payback is estimated from labor and energy savings associated with reduced maintainability requirements, and reduced environmental compliance costs.

Naval Surface Warfare Center, Indian Head Division - Indian Head, MD

Reengineering Propellant Extrusion Process

Indian Head Division (IHDIV) investigated several options for recycling double-based propellant scrap from the production of extruded propellants grains. The objective was to find alternative uses for scrap double-based propellant to avoid disposal of the propellant as a hazardous waste (HW). Additionally, the Navy had set a goal for 50% reduction of its generation of HW. Double-based propellant scrap was the top contributor of HWs generated on a yearly basis. Source reduction efforts initiated by the production division are reducing the waste from this process.

The following are projects initiated and implemented as a result of equipment upgrades in the Extrusion Plant to reduce the amount of propellant scrap by approximately 68%. These upgrades will also provide state-of-the-art ram extrusion and annealing capability for Indian Head Division's Ordnance Department.

Reduced Diameter Extrusion Dies

New dies with smaller diameters and more efficient cooling jacket will allow a smaller grain to be extruded under given extrusion parameters. The new die design has been implemented with encouraging results.

Upgraded Press Control and Hydraulic Power Systems

The press control upgrades consist of removing the present relay control circuitry and fixed flow control valves and replacing them with a programmable logic controller (PLC), a computerized operator interface, proportional pressure and throttle control valves, and a communications connection via fiber optic cable to the extrusion office's computers. These upgrades and improvements will allow the extrusion of propellant billets that require less machining to meet size requirements with less propellant scrap at the press operation.

New Flying Press Cutters

A new generation of automatic press propellant strand cutters will more precisely "rough cut" the propellant strand from the press into equally-sized billets automatically. Features of the new cutters will include a device to help center and guide the newly formed propellant strand away from the die, and an electronic encoder which will accurately measure each billet length, a clamping mechanism to help produce straighter cuts, and the ability to recognize, cut, and sort "pressneck" rejects.

Carpet Roll Weight Control

Control of the weight and diameter of carpet rolls received from the supplier will ensure exact propellant charge weight of "pressneck" rejects that can be accurately predicted and minimized.

Annealing Oven Control System

This system replaces individual analog reorder/controllers for each oven with a single, centralized PLC/operator interface type control system. The new system will allow an operator to start and monitor all ovens from a single control panel. The system will be connected to the office in the same way as the press control upgrades so any measurement can be recorded, analyzed, and achieved as well as cross-referenced with any other available measurement. Alarms connected to the telephone autodialer will notify foremen and engineers of any problems 24-hours per day.

Naval Undersea Warfare Center Division - Keyport, WA

HAZMIN Working Group

Background

Naval Undersea Warfare Center (NUWC) Division - Keyport instituted a HAZMIN working group to provide facility-wide coordination of environmental programs. Past management and coordination of hazardous waste minimization efforts were numerous, simultaneous, and autonomous prior to 1993. Although successful in many project areas, this approach lacked the infrastructure necessary to reach the program goals and objectives from a facility management perspective.

Problems identified with the previous approach demonstrated the loss of shared information on individual project efforts, including the identification of solutions and opportunities applicable to other areas of the facility, as well as the potential for redundant project efforts to occur simultaneously at different areas of the base. During the critical period of downsizing, Keyport recognized this area of weakness within the program and formed a facility-wide coordinated HAZMIN Working Group, led by a full-time program manager.

Description

An initial task included developing a consolidated strategic plan to outline the charter, short term, and long term program objectives. A facility-wide listing of ongoing and planned project efforts were consolidated into a facility plan. Waste stream generator ownership was assigned for waste stream life-cycle management. Environmental assessment and analysis data presented to the working group suggested 20% of the identified waste streams constituted 80% of the generated waste. These became the top priority and central focus of the pollution prevention program.

Results

A system to monitor and control the effectiveness of these changes was also necessary. Baseline data on waste stream volumes was used to benchmark the program's effectiveness, and a situational analysis was performed to determine the program's success. This cross-functional team approach has generated 700,000 pounds of waste reduction and over $3M in savings.

Lessons learned throughout the process indicate a vital need for top and mid-level management support, a stable membership commitment to the working group, and a technical support infrastructure such as chemists, metallurgists, and industrial hygienists, to call upon as needed to develop problem solutions. When developing a baseline assessment, a correlation should be maintained between waste stream generation and workload to assure data accuracy and project performance.

Norden Systems, Inc. (Northrop Grumman Norden Systems) - Norwalk, CT

Environmental Initiatives

Background

Achieving excellence in employee health and safety protection as well as the surrounding community and the environment is considered a continuous improvement process at Norden Systems. The company has implemented aggressive and comprehensive measures to protect the environment, and these policies have received strong commitment and support from top management at Norden and corporate management at United Technologies.

Description

Environmental efforts were initiated several years ago with a comprehensive baseline study to identify existing and potential sources of hazardous waste and emissions. A senior management steering committee and subordinate committees were formed. These committees continue to meet regularly and report to Norden and United Technologies senior management.

In addition to developing procedures, assessing compliance, and addressing environmental issues, Norden places strong emphasis on education and awareness training. Ongoing awareness training is provided in-house and through a commercial training program presented by DuPont. Periodic measurements are made and internal and external audits are regularly conducted to assess improvement.

Results

Since 1987, the company has reduced hazardous waste by nearly 50% and eliminated nearly 75% of its air emissions. Recent accomplishments have included reduction of DFX use, elimination of some chemicals, 60% reduction in solvent usage, removal of vapor degreaser exhaust systems, elimination of Freon 12 for cold test analysis, and asbestos abatement of 148,000 square feet of ceiling and floor tile.

Norden and United Technologies have eliminated the use of chlorofluorocarbons at the Norwalk, CT plant by implementing a No-Clean wave solder system for thru-hole technology and a semi-aqueous system for Surface Mount Technology. Norden is committed to going beyond basic compliance with environmental regulations by achieving the lowest levels of waste and emissions possible.

Oak Ridge National Laboratory - Oak Ridge, TN

Numerical Modeling of Environmental Problems

Background

Numerical modeling of environmental systems provides project managers with unique information that is simply not available from other sources. With its ability to quantify all aspects of problem physics, modeling allows one to rapidly accumulate the physical insight needed to solve a problem in a systematic and focused manner. This increased understanding acquired early in the planning stages of a project permits managers to make decisions that are typically more thorough, cost effective, and defensible to regulatory agencies and the public.

The Computational Physics and Engineering Division (CPED) of the Oak Ridge National Laboratory (ORNL) provides numerical problem-solving and consulting services to the Department of Energy (DOE) and approved organizations in support of a broad range of scientific, technical and engineering problems. CPED staff have extensive experience applying their technical expertise to environmental problems. Their combined modeling experience includes: transport of contaminants in air, water, and/or soil; plume and puff models; atmospheric radiation measurement data acquisition; hydrologic transport; sediment transport in rivers and estuaries; multimedia models; diffusion of contaminants through containment structures; groundwater flow through soils and fractured media; design of pollution measuring instrumentation; oceanic carbon cycle; indoor air circulation; evaluation of releases from nuclear, chemical, and biological facilities; thermal analysis of constructed wetlands; nuclear criticality at low-level waste sites; microflow in sapwood; and environmental monitoring and assessment using geographic information systems (GIS) technology. The following two examples briefly summarize the economic and administrative benefits of environmental modeling for site remediation and hazardous waste studies.

Example Application 1:

Site Remediation Studies at the Portsmouth Gaseous Diffusion Plant

To support the Correctives-Measures and Cleanup-Alternatives Studies (CMS/CAS) at the Portsmouth Gaseous Diffusion Plant (PGDP), a general-purpose soil-leaching computer model was developed to provide guidance in establishing cleanup goals for deep-soil contamination. PGDP, like many other industrial sites, has high soil concentrations of several different pollutants and over time these compounds leach from the soil and contaminate the groundwater. This studyfirst developed the analysis capability needed to estimate soil pollutant concentrations which would not cause groundwater contamination in excess of EPA guidelines, and then executed the code for several different compounds known to be in the PGDP soil.

Three aspects of soil-leaching physics were considered in the design of the model: the large number of soil, chemical, and weather variables that can affect groundwater pollution; the inherent uncertainty in these data; and the actuality that not all variables are significant for all pollutants at all geographic locations. To meet these criteria it was necessary to develop a probabilistic model and multi-step execution sequence. Two existing computer programs were merged to construct the model: **SESOIL** and **PRISM**. **SESOIL** is a one-dimensional chemical fate and transport code originally developed by Arthur D. Little, Inc. but significantly enhanced by CPED staff. For a given pollutant and set of input data, it will calculate a resulting groundwater concentration. The operation of the **SESOIL** code is shown schematically in Figure 3-3. **PRISM**

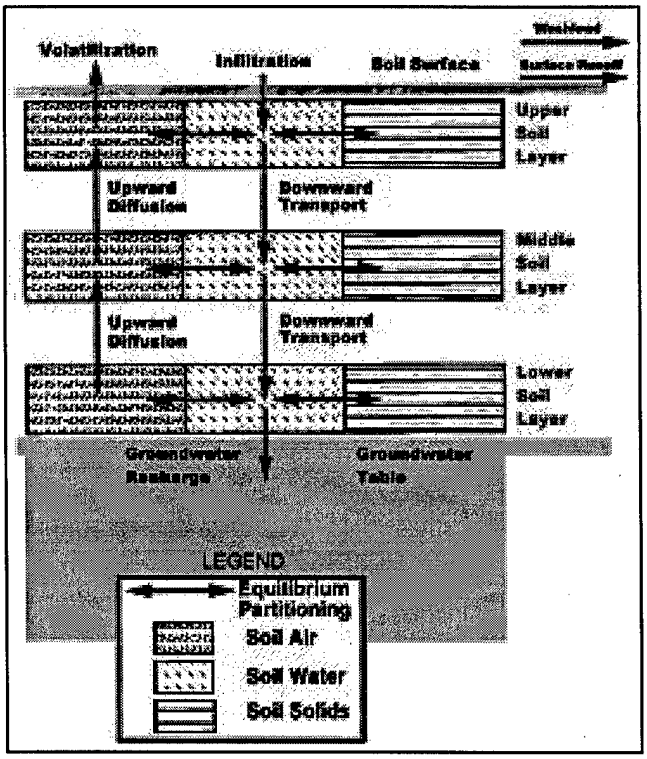


Figure 3-3. **Schematic Illustration of SESOIL Structure and Operation**

is a Monte Carlo-based probabilistic driver which utilizes a Latin hypercube sampling technique.

The **SESOIL/PRISM** code was constructed to perform two separate calculations: a sensitivity study to identify those variables which have a significant effect on calculated groundwater pollutant concentrations, and an uncertainty analysis to calculate a pollutant groundwater concentration probability distribution. An analysis begins by defining normal distributions for all soil, chemical, and weather variables. **PRISM** then randomly defines 200 equal-probability input data sets and passes each set to **SESOIL. PRISM** then statistically evaluates all 200 results to identify variables which have a significant effect on calculated groundwater concentration. In the second phase of an analysis, actual site-specific probability distributions are defined for the significant variables along with a deterministic value for the soil initial pollutant concentration. **SESOIL/PRISM** uses this information to calculate a probability distribution of the resulting groundwater pollutant concentration. Multiple **SESOIL/PRISM** runs are conducted for a range of initial soil concentrations to find that value which will not cause groundwater to be contaminated in excess of EPA guidelines. That value then becomes the preliminary cleanup goal for site remediation activities.

Once constructed and validated, the **SESOIL/ PRISM** code was executed for 60 pollutants known to be in the PGDP soil. These contaminants consisted of 40 organic and 20 inorganic compounds. Typical results of the study are shown in Figure 3-4 for trichloroethene (TCE). Figure 3-4a shows a typical TCE mass-flux distribution generated by **SESOIL/PRISM**. Figure 3-4b shows results from the successive submissions of **SESOIL/PRISM**.

Each data point in Figure 3-4b represents the final result of a single **SESOIL/PRISM** submission. Specifically it shows the 95th percentile value; that is, the groundwater concentration of TCE that will only be exceeded 5% of the time. Since the 50th percentile (50% probability) is generally considered the most likely value, using the 95th percentile insures a conservative answer. As Figure 3-4b shows, progressively lower initial soil concentrations were evaluated until the 95th percentile value equaled the EPA upper limit.

Numerical modeling benefitted PGDP managers by permitting them to define cleanup goals as a function of site-specific soil-leaching physics rather than generic EPA guidelines. Using a probabilistic execution sequence, where a range of model inputs

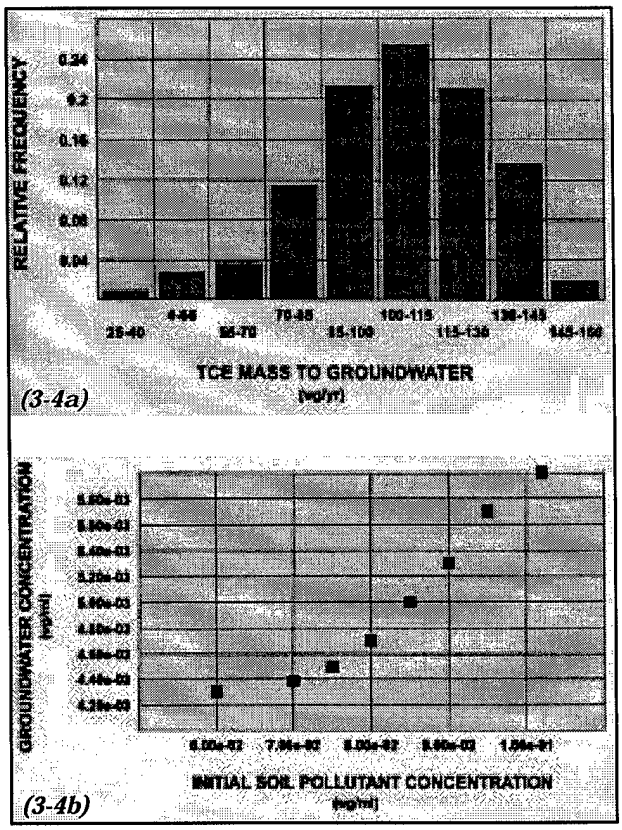


Figure 3-4. Typical Results from SESOIL/ PRISM Showing (3-4a) TCE Mass-flux Probability Distributions and (3-4b) Calculated TCE Concentration (95th percentile) in Groundwater as a Function of Soil Initial TCE Concentration

were defined from sampling data and consensus opinion rather than from an analyst's single-best guess, allowed program managers to better defend the cleanup goals. The conservative nature of the goals was firmly established by using only 95th percentile results. Again, the use of mathematical justifications rather than verbal arguments reinforced the managers ability to defend the cleanup goals.

Example Application 2: Integrated Hazardous Waste Studies Using Geographic Information Systems Technology

To clean up the legacy of environmental contamination and to comply with environmental regulations, U.S. government facilities must locate, characterize, remove or treat, and properly dispose of hazardous waste. The integration of geographic information systems (GIS) with other technologies provides an important resource to support hazard-

ous-waste assessment and management, remediation, and policy formulation for environmental cleanup of these facilities.

GIS technology can assist with both cleanup and regulatory-compliance tasks. This includes investigation of the types and characteristics of contaminants; the location of possible pollutant sources; previous waste disposal techniques; the spatial extent of contamination; relationships among nearby waste sites; current and past environmental conditions including surface, subsurface, and groundwater characteristics; possible pollutant transport mechanisms; efficient methods for analyzing and managing the information; effective cleanup strategies; and mechanisms for long-term monitoring to verify compliance.

Three programs that involve significant GIS activities in support of Environmental Restoration (ER) in the Oak Ridge area include the Oak Ridge Environmental Information System (OREIS), the Remote Sensing and Special Surveys (RSSS) Program, and the GeoSpatial Support (GSS) Program.

- OREIS is designed to meet environmental data management, analysis, storage, and dissemination needs in compliance with federal and state regulatory agreements for all five DOE facilities operated by Lockheed Martin. The primary focus of this effort has been to develop a consolidated data base, an environmental information system, and data management procedures that will ensure the integrity and legal defensibility of environmental and geographic data throughout the facilities.
- RSSS supports ER site characterization, problem identification, and remediation efforts through the collection and analysis of data from aircraft and other remote sensors. One example has been helicopter radiometric surveys to determine gamma radiation levels across mapped areas of DOE facilities.
- GSS promotes the development, maintenance, and application of GIS technology, data bases, and standards throughout the ER Program. The largest current activity is the development of base map data, digital orthophotos, and elevation models for all Energy Systems facilities using advanced stereo photogrammetric techniques based on real-time airborne GPS. When completed, these terrain data will be the most comprehensive GIS and orthoimage coverages of any DOE reservation.

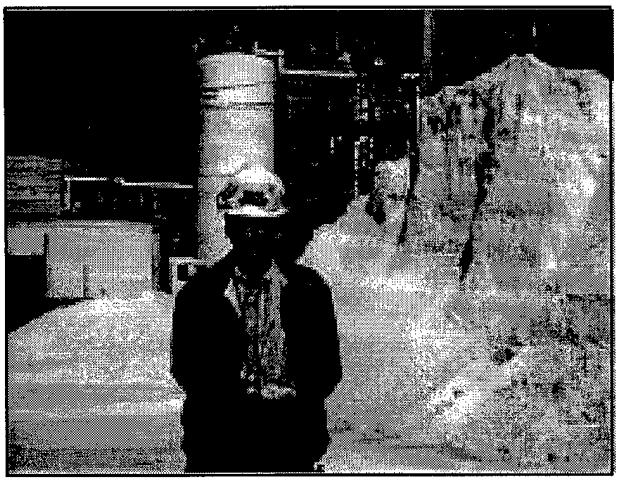
One project that demonstrates the potential cost savings and/or cost avoidances possible by the use of remote-sensing capabilities is the Waste Area Grouping 4 (WAG4) Study. Within WAG4, the Solid Waste Storage Area 4 (SWSA4) covers approximately 23 acres. From 1951 until 1959, SWSA4 received a variety of low- and higher-activity-level radioactive materials, including transuranic wastes, all buried in trenches or auger holes. Surface-water sampling indicated that a substantial quantity of ^{90}Sr contamination was being released from the SWSA4. burial trenches. It was estimated that these trenches contributed 25% of the ^{90}Sr release observed at White Oak Dam during the period of 1987 – 1994 and about 14% of the total ORNL off-site risk via the drinking-water pathway. Because of these releases, WAG4 was on the fast track for an interim remedial-action decision. However, because a fire had destroyed most of the WAG4 burial-activity records, an exact inventory of trench location and contents could not be defined.

To begin the process of developing a site-restoration plan and to determine the benefits of national remote-sensing technologies for environmental-restoration applications, remote-sensing imagery was used to produce a trench map of the WAG4 site. The map was based on historical and current remote-sensing as well as aerial-survey information. The trench map was then used by the WAG4 technical manager to define ground-based characterizations to further delineate the trenches. These subsequent investigations identified six individual seep areas, and suggested that two of them contributed over 90% of the ^{90}Sr being released from the SWSA4 area. Using this insight, a focused restoration plan was developed to deal with these individual sources rather than the entire WAG4 area.

The trench map was the key factor in defining a precise sampling study to pinpoint the localized sources feeding the major seeps. Without this map, it would have been necessary to collect and treat surface water from the entire site. It was estimated that this indiscriminate alternative would have cost approximately $5 million more than the focused plan. Remote-sensing technology was directly responsible for a significant cost avoidance at the WAG4 site.

OxyChem - Ashtabula, OH

Pollution Reduction Project - OxyChem's Ashtabula, Ohio Plant - Toluene Emissions and Releases Reduction



Background

Occidental Chemical (OxyChem) manufactures a paint additive at its plant in Ashtabula, Ohio. Toluene is used as a reaction solvent during the manufacturing cycle. The toluene is later separated from the additive and eventually disposed as a hazardous waste.

Production personnel identified the toluene by-product as a potential opportunity for waste reduction in 1991. In order to ensure end-product quality, OxyChem partnered with its customer to reduce waste generation, toluene emissions, and raw material usage, and to share in the economic benefits to be gained from the waste reduction effort.

An implementation team was formed consisting of the plant manager, production manager, process engineer, a chemist, lab manager, and the production foreman. The team wanted to recycle the toluene but found one major obstacle. Prior recycling attempts in 1988 recovered toluene that was not pure enough to be reused in manufacturing. The real challenge focused on recovering high-quality toluene that was within a specification that would be of value to future production of the additive.

Description

In laying out their new plan of attack, the implementation team identified key barriers to this project listing the customer concerns about the integrity of any new process, market risk, raw material/processing problems, and general resistance to change as major roadblocks to a successful result. By sharing information on the positive environmental impact and sharing any cost savings with its customer, the customer became a true stakeholder in the process. Adequate testing and certifications assured that the marketing and processing problems were not a factor in the change.

Through brain storming and suggestions from plant personnel, the implementation team hit on a different approach. Instead of stripping the toluene, as was done in the past, plant personnel suggested the use of existing idle equipment to distill the toluene from the additive. The distillation process effectively removed impurities from the toluene so that it could be recycled back to the manufacturing process. After the new process provided high quality toluene, and a favorable economic analysis was assured, the customer tested the paint additive.

Results

Successful lab tests and subsequent production trials finalized the approval process and resulted in a drop from 478,100 pounds off-site disposal waste toluene in 1992 (includes energy recovery) to 2,260 pounds in 1994. The project cost is less than $50,000 to implement and saves the company about $80,000 per year in disposal costs, a savings which OxyChem shares with its customer. In addition, the success of the project assured that the Ashtabula plant would maintain its status as a minor source under the Clean Air Act.

Overall, the implementation team felt that management commitment, plant personnel involvement, a commitment to pollution prevention by OxyChem and its customer, and the assured technical feasibility of the project were keys to the success of this pollution reduction effort.

OxyChem's Niagara, New York Plant

Background

OxyChem formally established Environmental Principles to guide management decision making and was among the first to embrace and implement the chemical industry's Responsible Care Codes® of Management Practice. OxyChem's chlor-alkali plant in Niagara Falls, New York was among company leaders in implementing a corporate wide pollution prevention program called OxyMin. All of OxyChem's domestic facilities committed to OxyMin's corporate goals of achieving a 10% annual reduction in air emissions, reducing water discharges by 20% from 1987 to 1993, and reducing hazardous and non-hazardous waste generation by 5% per year.

In addition to OxyMin, OxyChem and its employees recommitted to the Pollution Prevention Code® of Responsible Care, a voluntary industry-wide effort designed to improve the performance of participating companies in the areas of health, safety and environmental quality.

This commitment to environmental quality and efficient operation is exemplified by pollution prevention and emission reduction projects completed at the Niagara Falls, New York plant.

Located on a 100+ acre tract bordering the Niagara River about two miles upriver from Niagara Falls, the OxyChem plant employs 700 workers in the production of some two dozen products. The two largest volume materials, chlorine and caustic soda, find a wide range of uses such as water purification, plastics, detergents, and pharmaceuticals. The facility also produces hydrogen for the electronics industry, chlorinated toluene for computers, agricultural products, potassium sulfite for photographic chemicals, sodium hypophosphite for metal plating applications, and Dechlorane Plus®, a flame retardant used in computers and TV components. A promising new addition to this product mix is OXSOL®, a non-ozone depleting solvent.

Just about everything OxyChem does or makes at its Niagara facility is on a massive scale. In just one day 900 tons of chlorine are produced. The challenge that OxyChem and its workers face every working day is to operate a facility with operational and production capabilities of such large scale in an environmentally acceptable and safe manner.

One significant product, parachlorobenzotrifluorice (PCBTF), is used in the manufacture of herbicides for soybean and cotton farming, pharmaceuticals, and as a major component of OXSOL®. Residual untreated raw materials from the manufacture of PCBTF resulted in the following:

- A wastewater discharge to the Niagara;
- River containing significant suspended solids;
- 1,000 tons per year of solid waste sent to landfill;
- Neutralization and disposal of 9,200 tons per year of contaminated by-product muriatic acid.

Description

After review of various options, OxyChem decided to modify the PCBTF process to improve efficiency and product yield, such that unreacted raw materials were virtually eliminated. An additional reactor and facilities to recover and store the by-product muriatic acid were constructed.

Results

This project resulted in the following:

- Elimination of the 1,000 tons per year of solid waste previously sent to landfill;
- a 90% reduction in process wastewater generation;
- recovery and sale of 9,200 tons per year of by-product muriatic acid;
- elimination of the consumption of neutralizing agents for the muriatic acid.

The PCBTF process improvement project is but one example of the actions taken at the Niagara plant to reduce impact on the environment and improve manufacturing efficiency. Overall emissions have been cut by more than 80% since 1987. In 1993 alone, the Niagara plant achieved a 24% reduction in total emissions to air, land, and water over the previous year.

The role that incineration plays in how the plant safely handles large volumes of liquid waste material also is a continuing key in the sites's overall waste management/reduction story. OxyChem has operated a liquid waste incinerator at Niagara Falls since 1961. The incinerator has successfully incinerated more than 3,000,000 drums of liquid chemical wastes in a safe and environmentally sound manner.

Last year, OxyChem invested an additional $10 million in improvements, including a "state-of-the-art" scrubber system designed to meet and exceed contemplated new regulatory limits.

Continuous improvement of incineration technology, coupled with the continuing success of the OxyMin pollution prevention program, are tangible evidence that Responsible Care® is not only a goal, but a way of everyday life at OxyChem's Niagara plant.

OxyChem's Durez Ft. Erie, Canada Receives Environmental Awards for Environmental Efforts

Background

On December 8, 1995, OxyChem's Durez Canada was awarded the Certificate of Pollution Prevention Achievement by the Honorable Brenda Elliot, Minister of Environmental and Energy. The award was presented in recognition of efforts to reduce emissions and discharges to the environment. Now that the facility has achieved this level in the

Pollution Prevention Program, the Ministry has granted the use of special Ministry sticker and logos to advertise the facility's achievement.

Description

OxyChem Durez Canada produces resins and moulding compounds for various automotive, electrical and appliance markets. One of the main raw materials required in the manufacturing process is phenol. For years phenol presence in the sewer discharges was problematic, resulting in extensive testing and permitting requirements.

Results

This changed in 1992 when the facility closed looped the once through cooling system. The total cost for the installation was approximately $71,000 (US), with cost recovery within the first year. Consider the following benefits and associated cost savings from the project:

- Decreased Water Consumption
  Water consumption for the once-through cooling system was 80-90,000 gallons per day. The recirculating system reduced this demand to 10,000 gallons per day. This preserved a valuable resource and provided a cost savings in water and sewer charges of $60,000 (US) per year. Further decreases in city water usage are achieved by redirecting story run-off into the cooling system (this also diverts loadings from storm run-off).
- Decreased Phenol Loadings
  The recirculating system eliminated the direct discharge of phenol contaminated process cooling waters to the story system. This reduced phenol loadings to the Niagara River. This also removed the facility from the list of Direct Discharges To Storm Sewers, decreasing the amount of mandatory testing and reporting, a cost savings of approximately $35,000 (US) per year.
- Improved Production
  The system improved production during flaking. The new system utilized tempered recirculated water which eliminated the sticking and lumping of product on the flaker belt. This decreased the number of man hours and downtime involved in chiseling product from the belt, and concomitantly extended belt life. Savings are estimated at $15,000 (US) per year.

Pacific Northwest National Laboratory - Richland, WA

Electronic Signatures and Newsletters

Background

In 1995 the need to reduce operating costs and the desire to conserve resources caused Pacific Northwest to develop and implement an electronic signatures process and a policy regarding electronic publications. The electronic signatures process has been implemented for time cards and purchase requisitions, and eventually will be applied to travel requests, expense reports, and other forms requiring signature approval.

Description

An electronic communications team was established to publish newsletters and documents on the Internet, accessible to Pacific Northwest staff. In addition to publishing electronically, the existing newsletters were reviewed for content and several were eliminated, consolidated, and/or distribution times were lengthened. Almost all of Pacific Northwest's newsletters, guidance documents, user manuals, and many other documents are now published electronically, significantly reducing paper and printing costs, as well as future updating and distribution costs.

Results

These waste-minimization activities save money through decreased data-entry and printing costs, decreased paper purchases, and reduced disposal costs. The estimated paper-waste reduction is 5,000 kg per year. The initial implementation cost for these activities was $590,000 in 1995; no additional implementation costs have been incurred. The estimated cost savings for these waste-minimization activities was $440,000 in 1995, and is estimated at $730,000 per year for 1996 and beyond.

Quantitative Extraction of Organic Chemicals

Background

A Microscale Chemistry Pilot Implementation Project was initiated in fiscal year 1995. Through that pilot program, ten research projects received microscale chemistry equipment to reduce the quantity of waste their laboratories generated. The return on investment for these projects ranged from 62 to 200 percent. Nondestructive testing

methods and other instrumentation/automation technologies that are being developed can replace traditional wet chemistry and so eliminate wastes. These technologies are being pursued for implementation in many Pacific Northwest laboratories.

Description

Currently, Quantitative Extraction of Organic Chemicals is being used to replace the Soxhlet Extraction process for the characterization of organic chemicals in solid matrices. The Soxhlet process for extraction generated large volumes of hazardous waste in the form of used solvents by using 200-500 milliliters of solvent per sample and requiring extraction thimbles. The Quantitative Extraction process uses 10 milliliters per sample and does not require the use of extraction thimbles.

Results

The estimated waste reduction is 145 kg of hazardous waste per year. The initial implementation cost for these activities was $22,500; no additional implementation costs have been incurred. The estimated cost savings for these waste-minimization activities is $290,000 per year.

Polaroid Corporation - Waltham, MA

Chemical Labeling

Background

Polaroid makes chemical reagents for various coatings and developers. In the past, operators would weigh out the chemicals, place the amount into a plastic bag, and record the chemical name and weight on the plastic bag's label. This process depended solely on the operator to ensure that each chemical was correctly labeled and weighed for each batch. Implemented in 1992 and improved in 1996, Polaroid established a new labeling system which makes the process almost foolproof by bar coding the information required for each chemical. The operator scans the bar code into the computer that displays the weight amount needed and then produces a bar code containing information for the next stage in the process.

Description

Polaroid's chemical labeling process runs on a customized computer software package. Personnel connected with the process worked with a programmer to design each specific module for the process. The computer system can track a chemical from the time it enters the building as raw material until it leaves the building as a final product. In addition, the system includes all hazard communication (HAZCOM) information as part of the bar code label.

Upon receiving a product from the chemical manufacturing division, the operator scans the bar code. The computer system creates a new bar code, with all the HAZCOM information and directions for using the product, and places it over the original bar code. The new bar code remains on the chemical's package until the raw product is completely used. In cases where the package is large enough (e.g., drum), a safety HAZCOM sticker will also be produced and placed on the container next to the new bar code.

Once the new bar code is placed on its package, the chemical goes to the next operator who scans the bar code and receives information on the amount needed for a batch. If the bar code displays an incorrect lot number or chemical, the computer will alert the operator not to use this product. After weighing out the proper amount, the operator places the measured chemical into a plastic bag and attaches a bar code which describes the contents. Measured ingredients for a designated batch are placed on a cart and sent to the mixing vats. The operator then scans each measured ingredient's bar code before placing it into the vat. Upon completion of the final product, the operator places a new bar code on the vessel that holds the product. This bar code contains encoded lot numbers which identify the source and batch of each chemical used. After a final product is used up, its bar code is removed and its vessel is cleaned for reuse.

Results

By using bar codes, Polaroid's chemical labeling process improves the tracking of chemicals at each stage of its use and reduces operator error on weighing amounts. The computer system stores all pertinent information which can be accessed by authorized personnel (e.g., process engineers, operators, safety personnel), allowing for a more accurate chemical inventory. Major cost savings have resulted by virtually eliminating substandard batches, which in turn reduced scrap rates.

Drum Handling

Background

In 1994, the Chemical Operations Division began focusing on improvements that minimized or avoided injuries and hazards during material handling. Employee options for reducing drum handling risks included wearing back supports, using

mechanical aids such as forklifts, and increasing the number of personnel needed to move drums. In addition, the Division initiated the use of totes; pressure nutsches; eduction wands; and air-operated drum lifters/movers to further minimize or avoid injuries and hazards.

Description

Totes reduce the number of containers needed, eliminate manual labor as an option, and provide a safer mode of transportation for chemical substances. Typically, drums have a 55-gallon capacity while totes can hold between 300 and 400 gallons. The heavier totes reduce the risk of back injuries because they must be moved by a forklift. Discharging chemicals into totes for shipping helps reduce the hazard risks for shipping and receiving facilities. In one case, 48 batches of cyan dye required 240 drums per year. Polaroid replaced these drums with 48 totes. In a case involving sheet fluid, Polaroid replaced 280 drums per year with 40 totes.

Pressure nutsches reduce the number of drums needed for processing chemicals by filtering, washing, and drying chemicals in a single piece of equipment. Nutsches also minimize the risk of employee injury by using an internally-mounted blade to mix the chemicals and scrape material off the sides of the drum. For its opacification dye intermediate process, Polaroid reduced 192 drums to 40 which resulted in a 79% reduction in drum handling and provided operational/cycle-time, environmental, and safety benefits. Not all chemical processing can use the pressure nutsches because some chemicals may not filter well. In addition, these expensive machines cost $2.3 million apiece because special construction materials are needed to avoid reactions with certain chemicals.

Results

An eduction wand eliminates the need to lift or move a drum by vacuuming the solids out of the drum. By using eduction wands, Polaroid achieved an avoidance benefit of 1,200 drums per year. Air-operated lifters/movers allow an operator to remotely control the dumping of drums by mechanical means. Polaroid has installed two air-operated drum lifters/movers next to fixed mixing vessels which have the greatest drum use. The apparatus was originally designed by engineers and modified by operators to meet their requirements; thus, the handling risk for these operators has been lessened by 744 drums per year.

Through these various material handling options, the Chemical Operations Division has successfully minimized or avoided employee injuries and hazards. In addition, these improvements have produced operational/cycle-time, environmental, and safety benefits.

Early Suppression Fast Response Fire Protection

Background

Fire suppression is a critical need in warehouse settings. Traditional water sprinkler systems use small-size orifices to create a mist for controlling a fire but lack strong suppression capabilities. Three years ago, Polaroid began retrofitting its facilities with Early Suppression Fast Response (ESFR) fire protection sprinkler systems.

The ESFR system possesses several characteristics which distinguish it from a traditional water sprinkler system. The major difference is that ESFR systems rely on fire suppression rather than fire control. By using larger-sized orifices, the system creates bigger droplets of water which penetrate and extinguish the fire before a severe fire plume develops. In addition, the system uses a thin thermal link that generates an extremely quick response time.

Description

Early suppression can be achieved with ESFR systems if controlling factors such as actual delivered density (ADD) and required delivered density (RDD) are properly addressed. ADD, the rate at which sprinklers dispense water, will decrease over time. RDD, the density required to achieve fire suppression, will increase over time and is affected by the fire's size at the time of application. ESFR systems work most effectively with an initially-high ADD and a low RDD.

Results

Polaroid's implementation of ESFR fire protection sprinkler systems is one of the company's primary defenses against the threat of fire. By using a phased retrofitting process for installing the ESFR systems, Polaroid alleviated its insurance company's concern that high risk materials needed to be more effectively protected. Areas are being retrofitted as problems arise, and all traditional water sprinkler systems will eventually be replaced. All new buildings will be equipped with ESFR systems, where appropriate. ESFR systems cost approximately $1.50 per square foot.

Environmental Scorecard

Background

In the early 1990s, Polaroid recognized that its proactive approach to environmental regulatory requirements was very successful but lacked comprehensive metrics for tracking corporate environmental compliance performance. As a result, Polaroid developed the Environmental Scorecard in 1993, for use by top level managers, to measure and report emission excursions and official notifications of non-compliance.

Designed as a spreadsheet, the Environmental Scorecard tracks written violation documents; specific violations within the document; and excursions that extend beyond the allowed regulatory limits (currently not cited in documents). In addition, Polaroid established a three-level reporting and tracking system to provide insight into those areas which may become problematic but are not official violations. The three summary levels provide specific details on the Massachusetts Contingency Plan (sewer, air, and hazardous waste) and the Toxic Substances Control Act items for either the overall corporation or an individual facility. Accompanying data sheets to each scorecard detail the number of inspections and violations at a site, and also the specifics and penalties for each violation.

Description

Using the summarized data from the scorecards, Polaroid prepares monthly reports for the Vice President of the Global Supply Chain which document new items (e.g., excursions, notifications) and year-to-year comparisons of corporate environmental performance. The scorecard data also provides information for Polaroid's annual environmental report and identifies the operating results of plant managers and Environmental Operating Committee members.

Results

Polaroid's Environmental Scorecard provides a quick and efficient way for high-level managers to familiarize themselves with environmental compliance issues. In addition, the scorecard has been instrumental in allowing upper management to develop and discuss detailed corporate goals for achieving zero environmental regulatory excursions.

Ergonomic Program

Background

In 1992, Polaroid Corporation developed an ergonomic program and supporting guidelines to promote continuous health and safety performance improvements while maintaining product quality and sustaining profitability. Polaroid tests the effectiveness of its ergonomic improvements by incorporating a mission; policies; guidelines; job analysis evaluations; redesign methodology; in-house expertise training; and pilot programs.

To gain employee confidence in the ergonomic concept, Polaroid began its program on a volunteer basis. In addition, Polaroid built management commitment by establishing a clear set of expectations, potential results, and benefits. However, acceptance of the program did not go unchallenged for various reasons: expected increases in injury and illness statistics due to increased reporting; costs versus benefits concerns; and ergonomics being portrayed as more than mere common sense. Eventually, the program evolved from a volunteer concept through six phases into an auditable requirement in 1997. The program's next challenge involved educating the employees about their risks for work-related cumulative trauma disorders, encouraging them to report these illnesses, and identifying ways to reduce or prevent risk factors in the workplace. To successfully implement its program, guidelines, and methods, Polaroid relied on total quality ownership as a key tool to modify its employees' attitude and thinking toward ergonomics.

Description

Training, such as task analysis and evaluation, was a significant factor in the success of Polaroid's ergonomic program and allowed the program to be applicable at the corporate level. To date, employee-owners from several professional disciplines have been trained and are conducting analysis and evaluation training themselves, as well as training additional instructors. This approach enables a wider dissemination of required skills for conducting task evaluation and redesign, thereby improving the health, safety, and quality of the workplace.

Another important feature of the ergonomic program has been Polaroid's method of investigating and categorizing occupational injuries and illnesses by type and cause. These categories serve as a framework which are applied to all accidents. The reframing of the Occupational Safety and Health Administration (OSHA) statistics helps Polaroid

understand and address the underlying causes and consequences of workplace accidents. In addition, management receives the information needed to take preventive measures in the areas of greatest or immediate need.

Results

Polaroid's study, "Ergonomic Evaluation and Analysis of a Film Processing Task," demonstrated the task evaluation analysis and redesign methodology aspect of the ergonomic program. This study employed quantitative analyses on the film processing task by using frame-by-frame, detailed analysis of the task's steps, and then evaluated the results against established criteria to design, implement, and validate cost-effective solutions. Through this study, Polaroid demonstrated how its ergonomic analysis would significantly reduce or eliminate almost all of the extreme body positions and potentially-damaging wrist motions associated with the film processing task. These improvements were, in fact, confirmed by film processing operators. Table 3-2 identifies the risk factors, associated causes, and actual solutions which resulted from this study.

Another successful implementation of ergonomics occurred at Polaroid's Vale Camera Division in Scotland. A team of employees in the Medical Management program worked together to develop a procedure for identifying and reporting cumulative trauma disorder (CTD)/repetitive strain injury (RSI) at work. After pilot-testing and adjusting the process, Polaroid implemented the procedure. Although Polaroid does not claim to have solved all of the problems associated with CTD/RSI, the procedure did demonstrate how to understand, address, and identify solutions for avoiding or mitigating CTD/RSI disorders.

Polaroid uses its ergonomic program to improve the way employees relate physically and mentally to the workplace. By describing processes, implementing procedures, and examining statistics, Polaroid has achieved positive results from its program.

Local Emergency Planning Committee Membership

Background

Polaroid works closely with local community officials to keep them informed on the risk factors, hazardous materials used at manufacturing sites, and precautions taken to ensure the safety of employees and the public. Polaroid employees serve as members on community-based Local Emergency Planning Committees (LEPCs) to ensure an effective, ready response in the event of a hazardous material accident from any source in the community. LEPC participation also includes representatives from other manufacturing companies who work in partnership with the communities to ensure public safety. Polaroid contributes funding, equipment, and its expertise on environmental and safety issues.

Description

In 1995, Polaroid purchased computer hardware and modeling software (CAMEO) for the Waltham, Massachusetts LEPC. Local safety officials use the computer system to model and simulate various scenarios depicting the release of air emissions, maintain information on the chemicals used at local industrial sites, and store detailed maps of the area which pinpoint the locations of sensitive facilities such as schools and hospitals. The user can generate templates and map overlays that show the predicted spill footprints and air dispersion patterns under various conditions. The system can create detailed information on the effects of the material and appropriate responses for each environmental emergency scenario. Polaroid also provides computer training on this system for local officials and LEPC members.

Results

The success of LEPCs is largely a result of Polaroid's commitment to the community and strong emphasis on openness. The company provides regular reports, an environmental newsletter, plant tours for interested community members, and annual community meetings at its manufacturing sites. In addition, local emergency responders have access to the material safety data sheets for all chemicals used at Polaroid.

Process Safety Management

Background

As a large-batch chemical manufacturer, Polaroid produces various types of chemicals (e.g., flammables, carcinogens, mutants) at its film-producing facilities in Waltham and Freetown, Massachusetts. Operations typically run 24 hours a day, seven days a week, and produce 500,000 to one million kilograms of chemicals per year. Approximately 60 chemical processes which run at Polaroid fall under the volume or flammability criteria of the Occupational Safety and Health Administration

Table 3-2. The Workplace Risk Factors, Causes, and Actual Solutions

RISK FACTORS	CAUSES	ACTUAL SOLUTIONS
Potentially Damaging Wrist Motions	L/R Biological Clamp (camera). L/R Point Of Operation (P.O.O.) too close to body (load/unload camera). L Manual positioning/fixing of processed frames.	Holding device for cameras. Holding device for cameras. Holding devices for processed frames.
Extreme Wrist Positions	L P.O.O. too far away and angled too far away from body (film tray unprocessed). R P.O.O. too far away and angled too far away from body (film tray processed). R P.O.O. too low and angled too far away from body (light box).	Angled fixture for service trays and moved closer to operator. Angled fixture for service trays and moved closer to operator. Suspended Light Box overhead (also eliminated eyestrain).
Shoulder Flexion (extreme)	L P.O.O. too far away from body (grasping camera).	Holding device with cameras already installed.
Shoulder Abduction (extreme)	R P.O.O. too close and angled too far away from body (pulling tab empty pack).	Holding device for cameras.
Shoulder Adduction (extreme)	L P.O.O. too far to one side/ need both hands to hold/ place 5 processed packs in tray. R P.O.O. too far to one side (left) (flips empty pack places on table).	Positioned new angled trays closer to operator. Positioned new angled trays closer to operator.
Arm Pronation (extreme)	R P.O.O. too far away and angled too far away from body (processed film tray).	Angled tray towards body.
Elbow Extension (extreme)	L P.O.O. too far away from body (camera).	Cameras installed in holding device which eliminated this job task step.
Head Flexion 38°	Chair does not provide proper adjustments and support which leads to a variety of compensating postures to accommodate the seating. It also does not allow the operators to vary static posture during the day in order to eleviate muscle stress and increase circulation. Individual postural habits.	Provided new adjustable chair with usable arm rests.
Mechanical Stress of the Forearms	R/L Resting forearms on the edge of the desk.	Adjustable, padded armrests.

(OSHA) requirements. In May 1992, Polaroid began complying with OSHA's Process Safety Draft Document by establishing safety teams and committees at each chemical manufacturing site to interpret OSHA requirements, write policy manuals, and implement the procedures.

Description

New processes must undergo a hazards and operability study. Process analyses follow a safety information checklist to ensure all process factors are considered while process hazard analyses use a what-if format. To improve the ease of using its Process Safety Management procedures, Polaroid computerized OSHA's Process Hazard Analysis (PHA). PHA requires the involvement of all process personnel (e.g., operator, engineer, supervisor, building engineer, process engineer, chemist, electrical engineer, environmental representative). The procedures involve developing a process block diagram, analyzing the process' chemistry, and reviewing all material safety data sheets related to the process. Next, a draft report is generated and reviewed by all process personnel. The process engineer then prepares the final report on the process. Polaroid uses an Action Tracking System to sort and track action items by building or employee.

Results

Polaroid uses PHAs on all of its processes regardless of whether they fall under OSHA requirements. Any modifications to the process chemicals, technology, equipment, or procedures must be identified and reviewed before implementing the change. For personnel changes, Polaroid reviews the employee's training and skills to ensure an appropriate expertise level is maintained.

Polaroid's Chemical Operations Division has shared the procedures of its process safety management throughout the corporation. These procedures have improved the safety environment of chemical processes by effectively reducing the severity and risk of potential accidents.

Product Delivery Process

Background

Polaroid typically develops dozens of new products each year. To guide the development of products, Polaroid formalized a structured process in the late 1980s called the Product Delivery Process (PDP). PDP's purpose was to reduce the break-even cost and time; determine a programmatic development approach; and more clearly identify the individual responsibilities for new products.

The process focuses on seven steps: idea exploration; concept; feasibility; product development; design pilot; manufacturing pilot; and commercialization. A PDP team (Figure 3-5), led by a program manager, combines personnel from market research, product design, manufacturing, marketing, sales, customer service, and distribution. In

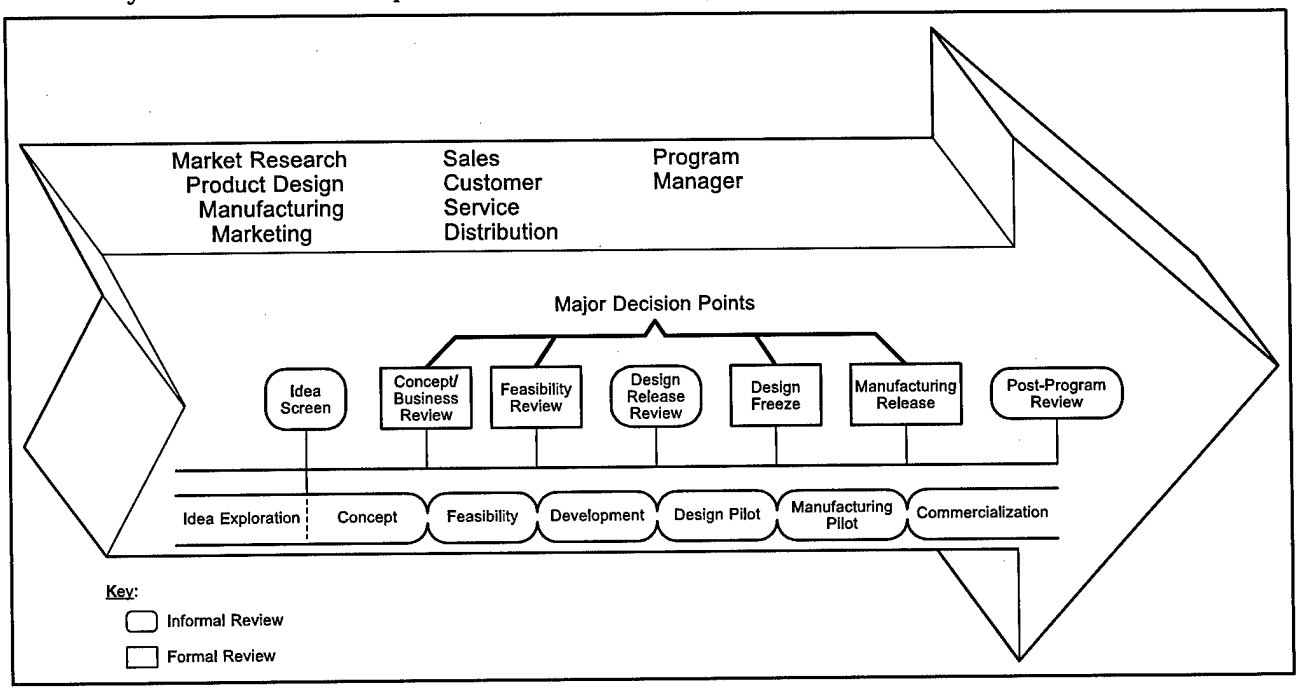


Figure 3-5. The Product Delivery Process Team

1992, Polaroid modified PDP by integrating the process with Design for the Environment (DfE) elements and manufacturability efforts. To ensure a successful DfE integration, Polaroid secured support from senior management and held process personnel responsible for their contribution. For example, Polaroid allowed program managers to control their own program budgets, but held them accountable for the program's performance.

Description

Specific DfE element changes to PDP were included in the concept and feasibility steps. Additions to the concept step included assessing environmental issues; examining environmental impact by the development program; identifying potential chemical, hardware, and packaging issues; and assuring that the product and its production comply with Polaroid's environmental goals. For example, Polaroid eliminated ozone depleting substances by removing the Teflon coatings on the friction points in its Captiva™ camera.

Results

Through its efforts to reduce the amount of silver needed for film processing, Polaroid developed a medical imaging product which was completely silver free. Additions to the feasibility step included specifically looking for opportunities to eliminate environmental problems; identifying substitutes for targeted chemicals to be eliminated (e.g., polyvinyl chlorides, chlorofluorocarbons); and examining the product for maximum usage of post-consumer waste (and reduction of the generation of consumer waste). For example, Polaroid was able to use approximately 63% of post-consumer waste content in its corrugated product packaging.

Polaroid continues to look for ways to improve its PDP. Current modifications underway include addressing additional environmental issues in the concept step and developing improved training methods for personnel who regularly use PDP in the workplace.

Reinforcing Safety Values at Polaroid Program

Background

Prior to 1989, Polaroid had an OSHA recordable incident rate of 2.4 while the average national manufacturers' incident rate was 8 to 9. In 1989, Polaroid established the Reinforcing Safety Values at Polaroid (RSVP) program. As a management tool, the RSVP program was designed and developed to reduce Polaroid's serious injury rate by 50% and to reinforce safety values. Polaroid's goal is to minimize accidents and eliminate hazards in the workplace and to enhance its leadership role in safety issues.

Description

Initially used as a tool for safety audit team members, the RSVP program has expanded throughout Polaroid's divisions. The RSVP program is also used as the basis for auditing six important aspects of its management system, and for performing in-depth root causal analysis of accidents and illnesses. The program's effectiveness relies on the following six critical factors for safety performance:

- Knowledge, which identifies and communicates safety responsibilities, workplace hazards, and required precautions.
- Ability, which ensures employees have the necessary capabilities and skills to do their jobs and tasks safely.
- Motivation, which confronts deviations from and generally reinforces safety values, rules, and expectations.
- Design, which applies engineering design safety standards and performs hazards analyses.
- Maintenance, which establishes and implements equipment and facility safety inspections and maintenance.
- Actions of Others, which instruct employees who impact the workplace, inside or outside the organization, and ensure their actions do not create unsafe conditions.

Results

As the governing components and foundation of the RSVP Accident Triangle, the six critical factors illustrate the relationship between accidents, injuries, injury causation, and injury prevention. These factors also show the underlying influences on individual behaviors and workplace conditions of safety performance. In addition, the six critical factors are part of the Evaluator, a tool to investigate and analyze accidents, and of the Preventor, a tool used for accident prevention. All these tools comprise the RSVP Pocketguide which employees receive as part of their safety training, along with the pocket-sized RSVP Polaroid Safety Guidebook and an in-house produced video. Risk Matrix is another part of the RSVP Program. This tool assesses hazard levels, establishes safety criteria, prioritizes opportunities for safety performance

improvement, determines acceptable and unacceptable risks, and justifies expenditures for corrective action.

Safety management programs are successful only if a company establishes safety and employee well-being as one of its core operating values. Polaroid's safety and health policy is firmly committed to this principle. Through its RSVP program, Polaroid has established a proven track record for plant safety. In 1996, Polaroid had an OSHA recordable incident rate of 1.4.

Safety Ambassador

Background

In October 1985, Polaroid decided to enhance the plant safety program at its Battery Division because of a rise in accident rates. As a result, Polaroid established the Safety Ambassador program. The program enabled Polaroid to improve the Division's safety record by making each employee a contributing element of the process and incorporating safety with other aspects of production. When implemented, the program provided meaningful measure and safety performance display metrics.

Description

For the program to be successful, Polaroid's first step was to involve its employees. Initially, only salaried employees became safety ambassadors; however, the program eventually expanded to include all salaried and hourly employees within the Battery Division. Employees were not trained as law enforcers but rather as ambassadors for continual safety improvement. Ambassador routes were developed to find known problem areas, potential hazards, and possible risk areas. In addition, formal check-off lists were maintained to record compliant and problem areas. Those areas requiring attention were noted and received corrective measures.

Results

Through its program, Polaroid reduced the Battery Division's injury rates by 50% and increased all employees' awareness on recognizing risk and problem areas (e.g., blocking exits, neglecting safety guards on equipment) which can affect safety within the plant. In addition, Polaroid operates the program as a recognition and reward system. Incentives for ambassadors include special designated parking spaces and "safety nickels" which allow employees to purchase film, cameras, and other company products.

Polaroid's Safety Ambassador program empowers employees to initiate improvement; recognize risk areas; and create and manage safety measures in their workplace. Polaroid's goal for its program is a zero-accident rate.

Safety Values Process

Background

Polaroid's Safety Values process works as a behavioral intervention program which reinforces the idea that health, safety, and well-being are every employee's personal responsibility. Begun in the early 1990s, the Safety Values process offered Polaroid a way to positively influence its employees' behavior by focusing on the motivations of an individual's action. The process' purpose was to reduce quantity and severity of personal injuries, as well as the associated pain and suffering.

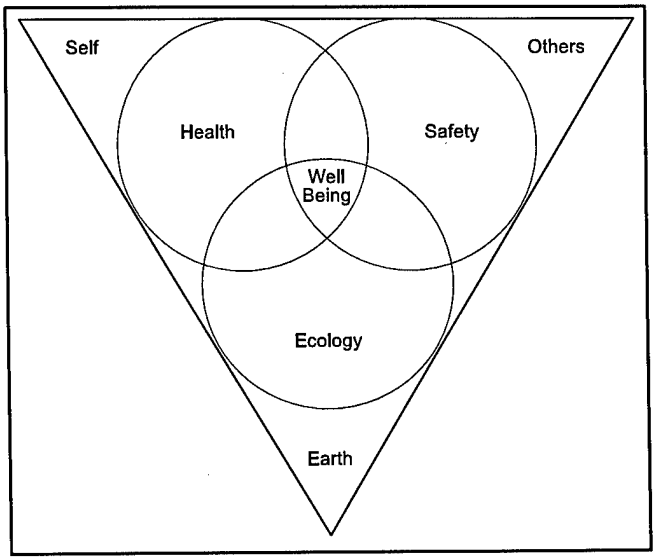


Figure 3-6. The Total Quality of Life Model

Description

Using the Total Quality of Life Model (Figure 3-6) as a starting point, the Safety Values process teaches employees to recognize and comprehend their behavioral motivation, identify the consequences from their actions, and take personal responsibility for their behavior. In addition, Polaroid uses a four-hour Safety Values Process Workshop as a first step to help its employees see their personal well being as an interrelated set of beliefs and values; behaviors; and consequences which extend beyond the

workplace (Figure 3-7). The workshop seeks to drive these beliefs and behaviors in the "safe" direction, and focuses on situations that threaten the quality of life and the ability to perform. As a companion to the workshop, a course book furnishes specific, personalized, thought-provoking facts, models, and exercises which encourage employees to modify their behavior through understanding, willingness, and commitment. In addition, the course book provides a straightforward, logical progression through complicated concepts that are expressed in simple, amusing, and user-friendly examples.

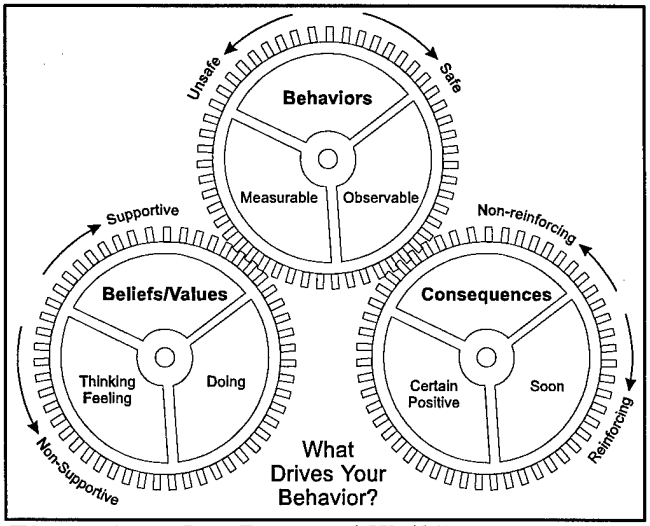


Figure 3-7. Our Personal Well Being

Results

After completing the workshop, groups of volunteers establish safety values teams to examine those behaviors requiring change or improvement. The group determines how the behaviors should be altered, gets support from other team members, and periodically measures and demonstrates the success rate of the team's new behavior. Safety values team members receive specific, additional training (e.g., conflict resolution, risk assessment, incident investigative techniques) as issues arise.

Polaroid's Safety Values process uses a forward-thinking approach which goes beyond the traditional guidelines, instructions, and handbooks. Instead, the process strives to understand and alter the behavioral causes of accidents and injuries; uses a continuous improvement technique; addresses each employee's well being holistically; and achieves significant practical safety improvements. Currently, 900 employees have completed the Safety Values training. As a result, Polaroid has reduced its accident rate by 50%.

Toxicity Bulletin

Background

In 1965, Polaroid published its first Toxicity Bulletin as part of its Consumer Product Safety program. The bulletin provides general information on the toxicity of Polaroid products and answers potential health and toxicity questions raised by customers.

Description

Polaroid's Customer Care Center representatives rely on the Toxicity Bulletin to answer customers' questions. The bulletin describes each Polaroid product, lists its hazardous ingredients, and specifies its toxicity. Recommendations are provided for appropriate treatment depending on the type of contact (e.g., eye, skin, oral) and for proper disposal. The bulletin also lists emergency contacts with office and home telephone numbers for those cases when more information is needed. These contacts are available to answer questions on a 24-hour basis. In addition, Polaroid distributes the Toxicity Bulletin to its security guards, telephone operators, and U.S. Poison Control Centers.

Results

Polaroid's Toxicity Bulletin provides effective and timely responses to customers' concerns. In addition, Polaroid identifies trends and recurring problems by documenting and reviewing all customer inquiries.

Free Cooling with Evaporative Fill Media Pads

Background

Approximately 15 years ago, Polaroid's facilities engineers began retrofitting and installing new process, manufacturing, and office space heating, ventilating, and air conditioning (HVAC) systems using evaporative fill media pads. As a result, Polaroid achieved virtually free humidification and cooling year round while maintaining a 52°F dew point discharge temperature. Concurrently, the air handling units were redesigned and retrofitted to incorporate the advantages of a positive pressure, blow-through system. This modification reduced the possibility of chilled water coils freezing in the winter due to air stratification; eliminated the need for a preheater coil; and extended the life expectancy of equipment by housing the fan, motor, and drive in a dry, contaminant-free environment.

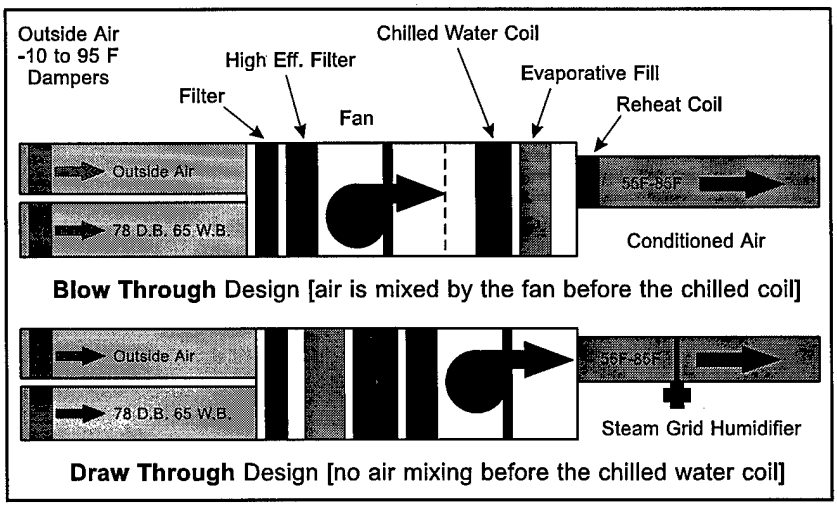


Figure 3-8. Heating, Ventilating, and Air Conditioning Systems

Description

Before the retrofit, Polaroid's HVAC systems were installed with a draw-through design (Figure 3-8) in which the outside air and the return air were drawn into a plenum where the prefilter, preheat coil, chilled water coil, and steam humidifier were before the fan. This design allowed air to return from the conditioned space and mix with the minimum-required outside air make-up. As a result, portions of the chilled water coils became susceptible to freezing damage caused by the improper mixing of the cold outside air, warm return air, and warm air from the preheat coils (installed primarily to preheat the air and protect the chilled water coil). As the cold air and the warm air in the plenum stratified, pockets of cold air would pass over the surface of the chilled water coil, freeze on contact, and rupture the copper lines in the coil. This event not only shut down the air conditioning system for comfort cooling, but in most cases, shut down the process cooling and the production line in that area. The design is also inherently inefficient. On cold days, the air in the plenum is often preheated, and then cooled to a temperature required to condition the space, typically 55°F to 60°F. In addition, humidity requirements were satisfied by a steam humidifier located before the fan, motor, and drive which subjected internal parts to moisture and encouraged rust, dirt, bacteria formation, and long-term destruction of the fiberglass insulation in the plenum housing.

By retrofitting the units and incorporating the use of a 16-inch evaporative fill media pad, Polaroid eliminated the original design problems and provided virtually free cooling to the conditioned space. In the new blow-through design, the fan was placed before a high-efficiency filter, the chilled water coil, and the evaporative fill media. This design allows the stratified air to mix properly within the fan before reaching the coils which eliminates preheat coils and potential freezing hazards. By using evaporative fill media pads, the design allows the unit to be constantly saturated with recirculated and filtered water and provides the required cooling and humidity conditions to satisfy the controlling dew point of 52°F.

Results

Benefits of Polaroid's new design are multiple and varied. Energy is saved through evaporative cooling by using the evaporative fill and a two-stage filtration, and eliminating the preheat coil. Other benefits include eliminating cost humidification; reducing the potential of the chilled water coil freezing in winter by allowing the stratified air to mix properly in the plenum housing; eliminating contamination into the unit via air leakage by placing the air under a positive pressure after the final filters; and housing the fan, motor, and drive in a dry environment by eliminating the direct steam injection into the air stream for humidification.

Moving Crates

Background

To accommodate the dynamics of its business structure, Polaroid has a constant movement of office employees. In the past, relocating employees required 15 corrugated moving boxes per employee for packing their office contents at a cost of $11.75 per box. Employee relocation over a 12-month period typically averaged 4,600 boxes. Polaroid recognized that the practice of purchasing corrugated moving boxes, recollecting them after a move, and then recycling the used boxes was a waste of natural resources and an unnecessary budget commitment. To rectify the situation, Polaroid purchased 100 plastic stackable moving totes with hinged lids at $20.00 each. These totes are loaned to employees and returned after each move.

Description

Although it has been using the plastic totes for only six months, Polaroid has already paid for its original investment, and the concept has been well received by the employees. In addition to the cost savings, these commercial-off-the-shelf totes have also created a labor savings. Previously, when an employee finished unpacking, the empty corrugated moving boxes were often tossed in piles for custodial collection which created an unsightly nuisance.

Results

In addition, the recycling process of the corrugated boxes required an employee to collect, transport, and bale the boxes in another section of the facility to prepare them for the recycler. With the reusable plastic totes, employees can insert and neatly stack the totes for custodial collection and reuse. The savings from this environmentally-friendly method continues to accumulate and will fund the purchase of another 100 plastic totes to support Polaroid for the future.

Power Factor Correction for Energy Conservation

Background

In 1975, engineers at Polaroid's Norwood Plant initiated a project to add capacitance to its inductive electrical load to increase the total power factor on its electrical grid. Typically, electric utility companies penalize commercial and industrial customers with a kilovolt ampere demand charge for poor power factor performance. Although the defining point of poor performance varies depending on the utility, poor power factor performance generally is defined within a range of less than 80% to 95% efficiency. The local electric utility company charges a demand penalty for power factor readings of less than 80% efficiency. Additional negative impacts of a continued poor power factor might include panel and circuit overloading or reaching practical kilovolt ampere limits of a substation.

Description

The easiest way to correct power factors usually involves installing some type of capacitor bank at the main substation used by the electric utility company to determine the kilowatt hour usage and demand charges. Effectively, poor power factor performance within the plant is then transparent to the electric utility company for billing purposes. However, this is not the best method.

On its own initiative, Polaroid's Norwood Plant raised its power factor and corrected any inefficiencies by installing capacitors on all motors greater than 25 hp at the motor, and capacitor banks in the motor control centers for all motors less than 25 hp. Capacitors were also added on all 15 kilovolt feeders within the plant.

Results

Polaroid increased its power factor to more than 95% by installing capacitors on its inductive loads. In addition, this method efficiently uses Polaroid's purchased electrical energy, directly conserves electrical energy, and reduces reactive power problems for the surrounding electrical grid.

Preheated Boiler Make-up Water

Background

Approximately five years ago, Polaroid purchased two new air compressors for its production operations at the Integral Coatings Division and integrated the water lines for the aftercoolers on these compressors with the make-up water lines for the high-pressure steam boilers. Typically, industrial-application air compressors are installed with chilled water lines or once-through municipal water lines attached to the aftercoolers. This setup keeps the compressor, oil, and bearings at a safe operating temperature by dissipating the resulting heat that was generated through friction and motor energy in the compressing process. The result creates the situation that one source of energy is consumed to generate another source of energy. For example, if chilled water is used in the aftercoolers, then the discharged water would eventually be returned to the chiller where mechanical and electrical energy would be consumed to re-chill the water and begin the cycle again. For once-through municipal water, the discharged water would be directed to the sanitary sewer (and probably not reused) as the heat from the compressor is removed by the water in the aftercooler.

Description

In Polaroid's situation, the proximity of the air compressors to the high-pressure steam boilers allowed the discharge water to be directed to the boiler as boiler make-up water to generate steam. Typically, boiler make-up water from a municipal source is approximately 50°F to 60°F. However, the boiler must consume more fuel than normal to

counter the effects of the cooler water re-entering the system. To solve this problem, Polaroid preheated the make-up water entering the boiler to 95 F by consuming the heat energy dissipated via the air compressors.

Results

Polaroid gained many benefits from its energy conservation technique: destructive heat is removed from the air compressor which allows the compressor to operate efficiently and reliably; additional mechanical and electrical energies are not sacrificed by using a chiller to generate another source of energy; preheated water from the compressor aftercoolers provides an excellent source of make-up water which does not compromise the efficiency of the high-pressure boiler; and expended water is not discharged into the sanitary sewer. Savings for the 750 hp air compressor system is $66,000 per year for preheating the make-up water to the boilers. Eliminating the use of chilled water to cool the compressors resulted in an annual savings of $94,000 in electric energy.

Ultraviolet Light Treatment

Background

Approximately eight years ago, Polaroid's Core Engineering Department began installing ultraviolet light water jackets for the humidifiers located in its air handling systems. These air handling systems service the comfort and health needs of the employee as well as the stringent production requirements for making instant print films. Treatment of the water used for humidification purposes is necessary to reduce the amounts of bacteria which would otherwise thrive in this constantly wet environment. Failure to condition the water would lead to poor indoor air quality, higher maintenance costs, and shorter life expectancy of equipment.

Description

Conventional methods of water treatment rely on chemicals that are costly, require high maintenance, evaporate in the air stream, and typically need subcontractor support. The chemical delivery system to the humidifier also uses pumps or maintenance personnel which may result in spiking when the chemicals are first introduced at their highest concentrations.

Results

Polaroid's ultraviolet systems have reduced the typical inlet condition from 200 to 10 colonies of bacterial growth per cubic meter. This improvement was accomplished by using a single pass through the ultraviolet water jacket before the water is introduced in the humidifier. In addition, Polaroid has reduced its humidifier maintenance by 75% since installing the ultraviolet systems.

Variable Air Volume Heating, Ventilating, and Air Conditioning System

Background

Approximately seven years ago, Polaroid began retrofitting the heating, ventilating, and air conditioning (HVAC) distribution systems at its Integral Coatings Division and installed energy-efficient, integrated, self-contained, thermally-activated diffusers on the variable air volume (VAV) distribution system for its comfort cooling applications. The modifications eliminated the need for zone thermostats and provided an energy-efficient way to maintain consistent, comfortable cooling.

Typically, VAV distribution systems are installed such that the air discharged from the HVAC unit is kept at a constant dew point temperature of 52°F; the static pressure in the duct is kept constant between 0.2 and 0.25 inches of water; and the volume of the air delivered through the diffuser is varied by a damper located in the respective branch distribution duct and controlled by a space thermostat. The result is an energy-efficient delivery system which requires no additional heat sources and makes optimal use of the sensible heat energy from the lights, equipment, and people in the conditioned space. The constant dew point temperature, cooled air is simply delivered variably. When the air is too hot, additional cool air is delivered to the space while conversely, when the air is too cold, less cool air is delivered. The drawback, however, is the higher capital costs and maintenance of the VAV boxes, and the need to install space air thermostats.

Description

For Polaroid's needs, engineers installed integrated, self-contained, thermally-activated diffusers directly connected to the distribution branches which eliminated the need for mixing boxes and thermostats. The diffusers are designed with a hydraulic mechanism which drives the diffuser blades open or closed, depending on the ambient space air temperature. The mechanism contains a cylinder with a heat-sensitive wax material that reactively contracts or expands, thereby increasing or decreasing the pressure in the cylinder proportionally. The

result is an even, consistent, energy-efficient delivery of cool air without using thermostats that require constant calibration and adjustment.

Results

Polaroid gained many benefits through its VAV HVAC system. By eliminating space air thermostats, Polaroid lowered its capital and recurring maintenance costs, and the need for constant calibration to ensure energy efficiency and comfort cooling. Other benefits include the elimination of higher capital costs associated with installing VAV boxes; increased diffusing performance which exceeds standard diffusers at equal cost; and greater energy savings associated with a maintenance-free VAV distribution system compared to standard VAV systems.

Community Outreach

Background

Although a very successful film-producing company in the early 1980s, Polaroid had not fully appreciated the surrounding community's increasing environmental concerns nor recognized the value of educating these neighbors on the company's business practices. In the middle 1980s, public interest groups, perhaps confused about the actual environmental practices embedded in Polaroid's manufacturing process, made public accusations against the company. Although these negative claims were often voiced without proper research, the public typically accepted the accusations. Polaroid's environmental leadership then realized they had very few avenues to disseminate correct data since the company had no formal method of educating the community. Recognizing the significant role which the local community had over industry through local environmental agencies, Polaroid responded to the situation with an open and honest effort by partnering with the local community.

Description

Polaroid opened its doors to the public through facility tours, community meetings, communication links, a community newsletter, and an environmental report which listed specific environmental information about the company. Besides community education, Polaroid also began creating internal educational programs for its employees to inform them about environmental issues and processes within the company.

Results

Polaroid now promotes community involvement and open communications within its facilities. Through community surveys and open meetings, Polaroid works with the community and recognizes that the residents' viewpoints and concerns may differ from those of the company. Polaroid receives several calls each year seeking its environmental leadership's assistance in interpreting environmental issues and recommendations. The trust created between Polaroid, its communities, and environmental groups has now become an asset to all involved.

Environmental Reporting

Background

Polaroid's corporate philosophy maintains that its business will be operated in an environmentally responsible and sustainable manner. One aspect of this responsibility entails keeping the company's stakeholders, including the local communities, informed on Polaroid's environmental efforts and performance. Polaroid has recently published its eighth annual report on the environment, the second of which follows the guidelines of the Coalition for Environmentally Responsible Economies (CERES).

Description

In 1987, Polaroid decided to publicly report its environmental data and reorientate the company's environmental programs toward pollution prevention. As a result, Polaroid developed the Environmental Accounting and Reporting System (EARS) and the Toxic Use and Waste Reduction (TUWR) program in 1988. The TUWR/EARS program's first year results were used to create Polaroid's first environmental report in 1989. This document, the first modern, data-rich, corporate-environmental progress report in the United States, targeted an audience of pollution prevention leaders; environmental groups and committees; and Polaroid's employees and shareholders. The intended audience for these environmental reports was expanded between 1990 and 1992 to include the government, other companies, and investors who were interested in socially and environmentally responsible companies.

In 1992 and 1993, Polaroid was one of just ten U.S. companies that worked together to develop a set of guidelines which could be used by companies to publish corporate environmental reports. These guidelines, published in 1994 as the Public Environmental Reporting Initiative, were designed as a tool

to assist organizations that voluntarily produce a balanced reporting perspective on their environmental policies, practices, and performances.

Results

Continuing its environmental leadership role in 1994, Polaroid endorsed the CERES principles which encouraged companies to conduct business in a manner that protects the Earth and applies environmentally responsible practices throughout the world. These guidelines marked Polaroid's expanded commitment to actively collaborate with environmental leaders and investors on operating its business in an environmentally responsible and sustainable manner. Polaroid's seventh and eighth reports on the environment are patterned directly after the CERES principles, including a clear cross-reference between the CERES report questions and applicable portions of Polaroid's annual report.

Fortune and *Tomorrow* magazines have recognized Polaroid for its leadership in corporate environmental reporting. Polaroid's internal efforts and external association with CERES and other U.S. premier environmental groups have enabled Polaroid to evolve its environmental program to a higher level.

Ethics and Compliance Awareness Training

Background

Polaroid's training directors recognized that a successful environmental training program required employee support not only from a compliance perspective, but also from an ethical awareness perspective. As a result, Polaroid has developed a unique training program which successfully instills personal ethical responsibility and stewardship concerning environmental compliance and behavior.

Like most corporations, Polaroid had established regulation-specific training modules which offered compliance awareness as required by the Resource Conservation and Recovery Act, the Department of Transportation, HAZCOM, and other local regulations. This training focused on the technical aspects of environmental issues but failed to inform the employee on the ethical aspects. Drawing on Polaroid's success from its business conduct module on ethics, the developers of the environmental awareness program established the training as a co-sponsorship between Corporate Health, Safety, and Environment and the Office of Ethics and Compliance under an umbrella of corporate ethical behavior.

Description

The Ethics and Compliance Awareness Training successfully changed employees' way of thinking (e.g., question whether the environmental procedure was valid; influence the way decisions were made; determine the environmental impact). The training featured two hours of business significance and legal aspects of environmental compliance, which was customized for the local divisions. Polaroid used local environmental managers as the program trainers. These managers were able to have their employees share ownership and responsibility for their particular local work area.

Support for Polaroid's unique approach was built by enlisting the endorsement of top managers throughout the company. A total of 29 trainers were trained to implement the program and were then allowed to develop specific guidelines unique to their areas. Polaroid initiated the Ethics and Compliance Awareness Training in September 1996 and has already trained more than 95% of its employees. Evaluation data indicates that 89% of the employees have a greater awareness of their own and the company's environmental responsibility; 86% have a better understanding of how the laws and regulations relate to their workplace; 82% will participate in identifying and correcting environmental problems; and 92% commended the program trainer on a well-informed session.

Results

Polaroid's Ethics and Compliance Awareness Training has instilled its employees with a better awareness and greater sense of responsibility. The employees are more willing to impact environmental performance directly; identify risk areas that may have gone unnoticed; and contribute toward improving the company's environmental performance each year.

Occupational Medical Program

Background

Dr. Edwin Land, the founder of Polaroid, envisioned complete healthcare for all employees and their families. Polaroid's Occupational Health Department began as a family practice health clinic for its employees and evolved into an occupational health clinic. Polaroid promotes and supports healthy work environments and healthy lifestyles for its employees.

Description

Using an employee-oriented approach, the Occupational Health Department takes a major role in preventive medicine for Polaroid employees. The Department maintains three full-time doctors and 13 nurses for its five medical facilities throughout the company. Specialty services (e.g., orthopedics, psychology, and dermatology) are also provided by the Department once a week. Each medical facility is equipped with state-of-the-art medical equipment and laboratories. Polaroid's preventive medicine practice includes free complete physicals every three years for employees over the age of 40; gynecological exams and prostate exams for employees; and unlimited consulting for alcohol/drug abuse and stress. In addition, the Occupational Health Department offers wellness programs; informs employees of options such as living wills; and operates support groups for diabetic employees. Through their experience and understanding of Polaroid and its culture, the clinic doctors provide employees with quality medical services.

Results

Polaroid's Occupational Health Department provides various benefits through its employee-oriented approach. Besides quality medical service, employees receive a sense of well being through an experienced and caring medical staff. In addition, Polaroid management supports the medical program as a top priority benefit for its employees. Overall, Polaroid increases employee moral and creates a better working environment.

Polaroid Exposure Guidelines

Background

In 1968, OSHA regulated permissible exposure limits (PELs) for almost 800 chemicals. These PELs, based on an earlier concept established by the American Conference of Governmental and Industrial Hygienists (ACGIH), identify safe worker exposure limits to air contaminants. However, detailed procedure requirements make regulation difficult to modify as new information becomes available. The National Institute for Occupational Safety and Health (NIOSH) proposes its own limits for chemicals known as Recommended Exposure Limits (RETs). These multiple exposure limits for a given chemical, combined with the trend of tightening environmental regulations, motivated Polaroid to establish its own, very conservative approach for identifying exposure limits.

Description

In the late 1970s, Polaroid developed Polaroid Exposure Guidelines (PEGs) for materials handled in significant quantities based on current literature and toxicity test results from Polaroid-sponsored studies and existing established limits. PEGs are usually set at one-half of the lowest limit of an existing PEL or ACGIH, or less if the Polaroid review team deems it to be prudent. Although PEGs are self-imposed guidelines rather than federally-imposed limits, Polaroid strives to maintain that worker exposure is less than these guidelines. Polaroid's existing site evaluation and monitoring programs verify their compliance with PEGs. If exposures deviate beyond PEG limits, then Polaroid takes prompt corrective action.

Results

If official or unofficial guidelines do not exist, then the PEG is based upon known and suspected toxic effects, governed by a rating system designed for this purpose. Among other advantages, conservative PEGs are used to anticipate downward shifts in the OSHA PELs. Goal setting is straightforward since only one source exists for the guidelines, and no one needs to struggle to meet a more stringent requirement. Polaroid can quickly respond to new test data on exposure hazards as the company has an existing mechanism to incorporate that information with its company policy. This guideline program has existed for more than 15 years and has proven to be a satisfactory mechanism for practicing workers' health protection.

Polaroid Foundation

Background

Twenty-five years ago, the Polaroid Foundation was established with a mission to support nonprofit organizations that provide services to those less advantaged. Beginning in 1997, Polaroid refocused that mission to include services which promote life skills development to those less advantaged. Geographically, the Polaroid Foundation concentrates its grants in Massachusetts, especially in those communities where Polaroid has its facilities. To evaluate submitted proposals, the Polaroid Foundation set up committees for culture, education, community, environment, and the New Bedford area. After the 1997 mission revision, the Polaroid Foundation regrouped its committees to include one for Greater Boston.

The Polaroid Foundation operates on an annual budget of approximately $2 million which is provided by Polaroid. After an initial screening by the Polaroid Foundation for proper grant application requirements, the proposals are distributed to the appropriate committees. These committees of self-invested employee-owners decide which proposals should be funded.

Description

In 1993, the Polaroid Foundation established an Environmental Committee because of Polaroid's values and potential impact on the environment. This would assure that environmentally-related proposals would receive priority when evaluated against criteria developed for this purpose. The Environmental Committee develops its own evaluation criteria based on outreach, education, organization stability, and program characteristics.

Results

The Polaroid Foundation is one of many ways in which Polaroid demonstrates its involvement in the surrounding communities. The philanthropic activity promotes the well-being of the local area and its citizens; reinforces the support of the community; and allows Polaroid employees to select which community activities to support. Environmental grants totaling more than $130,000 have been awarded over the last four years, ranging in amounts from $1,000 to $7,950.

Proactive Roles with Public Groups, Boards, and Committees

Background

Polaroid recognized that environmental-policy development by agencies benefits from full understanding of the nature of business and industry. In response, Polaroid's Environmental Leadership Group is actively involved in external environmental activities in addition to its complex reporting, planning, and maintenance duties on environmental compliance issues. The Group's members donate their time to participate proactively with public groups, boards, and committees which help influence public policy and environmental statutes and regulations.

Description

Polaroid believes these regulatory actions are necessary for the long-term health of our planet. Through its participation, Polaroid offers its environmental and business expertise to these regulatory agencies to assist them in understanding the applicability and interpretations of regulations as they are being developed. Polaroid's commitment is evident throughout the corporation by offering business perspectives at the national, regional, state, and local levels. The opportunity to work closely within the surrounding communities of Polaroid's facilities has helped the company build trust and understanding with the communities, residents, and environmental groups.

Results

Polaroid's proactive environmental leadership with public boards and committees has yielded many benefits between the company and the communities. Among them include more livable regulations and better interpretations of laws and regulations by agencies so industry and communities can obtain common goals.

Product Safety Management Guidelines

Background

Polaroid has always ensured customer safety by conforming with consumer protection laws. However, the Product Safety Committee, set forth by company policies and procedures in the 1970s, typically used a reactive approach and was subject to frequent membership turnovers. In addition, this reactionary and inconsistent approach to product safety made accountability difficult to track. No employee or manager felt personally responsible for the safety issues. In 1993, Polaroid began to transform its Product Safety Committee from one that primarily reviewed information into a more proactive, comprehensive product safety program.

Description

Polaroid established co-directors to lead the company in ensuring that all existing and new products meet Polaroid's product safety standards. To supplement the existing safety policy, the co-directors developed the Product Safety Management Guideline which is based on the elements of International Standards Organization (ISO) 9000 and 14000, although currently not audited. The Product Safety Management Guideline emphasizes that safety planning must address all stages of the product from concept, design, and development through customer use and disposal. The guideline targets safety strategies for employees who build the product, installers of the product, operators, maintenance personnel, and even bystanders. In addition,

the guideline addresses product recall procedures; product testing for applicable national and international standards; establishment of responsibilities for managers, directors, and review committees; and annual reviews of management practices.

All managers are trained on Polaroid's philosophy. A risk assessment evaluation is required for each new or existing product, and a methodology for assessing risk is discussed. Critical definitions are explained to provide universal understanding of terms (e.g., substantial product hazard, safety, danger) which may have connotations other than those in the guideline. Employees have easy accessibility to the co-directors in case safety questions or issues arise after formal training. The frequent contacts indicate that Polaroid has a sound communication network in place.

Results

In November 1996, Polaroid published its final version of the Safety Management Guideline which is auditable per ISO requirements. The practices set forth in the guideline save time and money because safety concerns are discovered and averted in the early stages of product design and development. Since implementing this guideline, Polaroid has not encountered any issues beyond the prototype development stage. In addition, company awareness has increased, and employees know a safety answer is only a telephone call away.

Professional Development Committee

Background

Polaroid has a tradition of helping employees improve their work-related knowledge and skills. To provide additional focus in the areas of health, safety, and environment, Polaroid established the Professional Development Committee (PDC) in 1994 which assists company HSE employees in their continued skill development.

Polaroid recognized that their HSE employees need a high level of technical competence, business insight, and personnel leadership. In addition, these employees face a continual learning challenge due to the day-to-day demands of their jobs and ever-changing regulatory requirements. As a result, their longer-term professional development tended to be neglected. To resolve this situation, Polaroid uses its PDC to update and educate HSE personnel on the skill requirements for promotion; standardize the HSE job family and job titles; offer ongoing professional training; and build a community of shared learnings on an HSE Intranet home page.

Description

In 1994, Polaroid identified skills development as a top priority area within its corporate and matrix organizations which needed improvement, especially in the technical and leadership/management areas. Employee learning method preferences included coursework, on-the-job-training, and specific project assignments. Therefore as part the PDC's focus on professional training, Polaroid developed a PDC Development Planning Kit. Based on the objective of helping HSE personnel, the Development Planning Kit clarifies their vision of career and/or personal achievement goals; develops a plan to reach those goals; identifies specific skills improvement activities with a timeline for accomplishing them; and enhances the supervisor's understanding of the PDC work and support for skill improvement. In addition, the Development Planning Kit provides details to the employees on how to conduct their own goal-setting effort. These goals are then reviewed with the employee's supervisor, and a skills assessment of the employee is conducted by a professional and the employee's supervisor. A portion of the skills assessment tool is the Checklist for Individual Development Planning which addresses knowledge areas such as environmental health; safety; leadership skills; communication skills; business environment; administration skills; community and professional engagement; and personal effectiveness skills. These efforts support employees in their pursuit of knowledge and skills through learning plans and management commitments.

Results

Polaroid's PDC focus on HSE established a framework and guide for employees and supervisors to maintain and ensure skills development through educational support, relevant monitoring, and successful progression. Employees who used Polaroid's PDC Development Planning Kit have benefited from self-assessment and achieved positive results from their learning plans. In addition, supervisors have gained a better understanding of HSE job responsibilities through the Development Planning Kit and regard it as a useful tool for supporting employee development.

Project Bridge

Background

Polaroid's Project Bridge began 15 years ago as a unique community human resource program with the local school board. Teachers take a one-year sabbatical from their academic responsibilities and work in a Polaroid facility. The experience allows the teachers to gain valuable life experiences which they take back to the classroom and enhance the educational teachings of the community's young people. In addition, Project Bridge has successfully helped teachers understand the relationship between their academic subjects and industry applications.

Description

During the sabbatical, teachers continue to receive their school's employee benefits package, and the school system receives a reimbursement from Polaroid for the teachers' salaries. Project Bridge also complements Polaroid's intern program, another highly successful community outreach. Polaroid supplements its permanent workforce with students who work for the company while attending colleges and universities. The company pool of prospective applicants is derived from universities, environmental career organizations, minority programs, and resumes. Internships at Polaroid benefit the student's understanding of industrial and business processes, and identify real-world applications of academia requirements.

Project Bridge, the internships, and other human resource community sharing programs demonstrate Polaroid's interest and continued commitment to the surrounding communities. In return, Polaroid gains insight from experienced people who are eager to share their knowledge, and from students who bring an academic perspective on business.

Results

Teachers and students benefit from exposure to real-world business experiences and problems, which they can then apply to their classroom setting. These programs also offer a savings for Polaroid compared to the outsourcing of work to local subcontractors; improve its image by having community members involved in daily operations; and add to the relationship between Polaroid and the local communities by openly sharing information.

Regulatory Training Requirements

Background

Several regulatory agencies require companies to provide environmental training for every employee. Although regulatory agencies may have similar training requirements, each agency involves specific topics to be addressed for compliancy. In the past, Polaroid would conduct separate classes for each compliancy which required employees to spend several hours per year away from their workplace. Since the regulatory requirements overlapped from class to class, employees often sat through redundant lectures. This technique also proved costly for the company as well. To remedy the situation, Polaroid developed a consolidated approach to its safety and environmental training.

Description

Polaroid's consolidated approach streamlined its training effort by grouping similar requirements into a package which met the criteria of several regulatory agencies at the same time. For example, one of the consolidated training packages groups the requirements for the Hazard Communication (HAZCOM) standard; the Occupational Safety and Health Administration (OSHA); the Resource Conservation and Recovery Act (RCRA); and the Department of Transportation (DOT). The HAZCOM, OSHA, RCRA, and DOT training package covers all necessary requirements at one time, creates a consistency in the level of understanding for the employees, and reduces the opportunity for noncompliance issues.

Results

By consolidating regulatory training requirements, Polaroid decreased the number of training classes, reduced its employees' downtime from the workplace, and increased its employees' comprehension level. Polaroid's training program was developed on Microsoft PowerPoint, is readily available for use at various sites, and can be easily modified for specific site needs.

Raytheon Missile Systems Division - Andover, MA

ODC Reduction

Background

In 1990, the Raytheon Corporation chartered the Office of Manufacturing and Environmental Quality to eliminate ozone depleting solvents by the end of 1992. This is a company-wide initiative with 36 representatives from 17 Raytheon facilities. The objective is to eliminate ozone depleting solvents used for cleaning CCAs throughout all phases of the manufacturing process. Raytheon maintains that once that objective is accomplished, acceptable alternatives can be easily used in other solvent applications.

Description

To accomplish this effort, Raytheon MSD has employed a two-phase approach. Phase I identified those possible candidates for both chemistry and machine suitability for the Raytheon CCA cleaning needs. Phase II established a pilot facility at Raytheon MSD Andover and evaluated those candidates which pass Phase I testing.

Phase I testing involved the design and manufacturing of test boards, vendor visits, development of a detailed test plan that paralleled IPC, Environmental Protection Agency, and DOD testing, and the performance of cleanliness testing through visual inspection, surface insulation resistance, ionic resistively and liquid chromatography. Phase II involved the establishment of a pilot facility at Andover; development of standard cleaning processes; further evaluation of alternate cleaning solvents from Phase I in a manufacturing environment; evaluation of closed-loop rinsewater systems; and performing product qualification.

The Raytheon Corporation conducted an extensive investigation into the elimination of ozone depleting solvents.

Results

Their effort is corporate-wide with total participation. It again demonstrates the ability of the Raytheon Corporation to achieve integration and solve problems at a corporate level.

Rockwell Autonetics Electronics Systems - Anaheim, CA

Approach to Achieving 100 Parts Per Million Program

Background

Rockwell Autonetics Electronics Systems' (AES') current method of electronic components screening includes component environmental stressing including source-inspection surveillance of environmental stressing performed at the vendor. Receiving and inspection is also performed at Rockwell AES for those components which are not source-inspected. Rockwell AES additionally performs in-circuit and printed wiring board functional testing, environmental stressing and assembly functional testing, and system burn-in and test.

Even with this screening, Rockwell AES was concerned with the quality of parts and cost impact of rework on higher level assemblies, including the system level. A component yield reporting and corrective action program was therefore initiated. The program approach is to collect component yield data by collecting data on which components fail during board, assembly, and system level testing. Component defect reports are issued on a monthly basis. The first report was issued in April 1989.

Description

Rockwell AES collected the following data for a particular program. From April through September 1989, over 450,000 components were tested during the board, assembly, and system level testing. There were 50 components which failed and had to be replaced. The distribution was integrated circuits (ICs) - 54%, resistors - 20%, transistors - 18%, capacitors and diodes - 4% each. These figures related to the following parts per million (PPM): ICs - 375 PPM, resistors - 50 PPM, transistors -385 PPM, capacitors - 20 PPM, and diodes - 100 PPM. Within the 450,000 components, there were 646 different part types of which 30 part types were responsible for the 50 component failures. Further data analysis showed that one transistor part number was involved in 56% of the replacements.

Results

Rockwell AES currently analyzes the data to determine which component vendor is responsible for which failures. This data is then used to develop a software process improvement. This index is combined with the vendor's quoted price to determine the total projected cost, thereby determining which vendor will be awarded the contract.

Long-range plans for the program include the development of vendor/Rockwell AES component teams to evaluate performance data, indicate corrective actions, identify components requiring additional screening or tests, and evaluate corrective actions. Rockwell AES, together with the vendor, will develop the acceptance criteria for those parts which meet and those which exceed the 100 PPM criteria. Rockwell AES will continue to award contracts based on the real cost of components, not just the quoted cost.

Rockwell Collins Avionics & Communications Division - Cedar Rapids, IA

Automated Conformal Coating Application Process

Background

Rockwell Collins Avionis and Communications Division (CACD), Coralville uses an alternate conformal coating process that satisfies environmental requirements while realizing many other advantages. Since 1993, Rockwell CACD has used a customized, automated conformal coating system from the Nordson Corporation to eliminate problems associated with the traditional spraying application method such as required masking, increased solvent release to the atmosphere, and substantial labor efforts.

Description

Rockwell worked with Nordson to customize the system to Rockwell requirements. The Nordson Select Coat is an in-line workcell comprised of a coating workstation, workcell system controller, and in-line ovens for pre- and post-coating processes. The coating workstation includes a five-axis gantry robot that moves in the x, y, and z directions, as well as 30-degree tilt and a 90-degree incremental rotation. Operations such as coating gun movement, actuation of pneumatic valves, conveyor speed, temperature control, time duration, and overall operations are controlled by the workcell controller.

Results

The system uses laminar flow as the application method. Although similar to spraying, the application method virtually eliminates overspray by using lower pressure (10 psi versus 30 psi). Lower application pressure removes the atomization experienced at higher pressure levels. Because of the ability to control overspray, masking is not required and cleanup is simplified. Labor and cycle time savings are achieved by eliminating two production steps—masking and unmasking. Because the system has a heater, higher viscosity materials can be used with the advantage of being more environmentally friendly since less solvent is required. The application head is also positioned closer to the product (< 0.5-inch) using laminar flow.

This system, which also has an oven preheat and an infrared and convection curing oven, is a complete workcell and has proven to be a good investment for Rockwell CACD production while remaining environmentally friendly.

Freon Replacement and Hazmat Program

Background

From 1991 to 1992, Rockwell CACD surpassed EPA requirements for reduction of hazardous material consumption with a reduction of 1,471,650 pounds of all toxic chemical consumption, and an 885,702 pound reduction of freon and trichloroethane alone. This effort was in response to the EPA voluntary program to reduce emissions of 17 toxic substances. The EPA program called for a 33% emissions reduction by 1992 from the 1988 base level, followed later by a 50% reduction from the 1988 base level.

Description

In continuing support of the Montreal Protocol, CACD has formulated short-term and long-term plans to eliminate ozone depleting substances. The short-term plan includes converting cleaning equipment to alcohol-based cleaning, with a specific focus to convert manufacturing defluxing processes to alternate materials by 1 July 1994. This goal has been met by using a Kyzen SSA cyclic alcohol and DI-water rinse for the in-line and stencil cleaning equipment, a Kyzen HC or Kyzen FC-R cyclic alcohol and DI-water rinse for batch cleaning equipment, and a water soluble flux (Alpha WS360 or Alpha 630) for tinning of parts.

The long-term plan centers on developing a method to clean PWAs using water only. CACD must investigate water soluble fluxes and water washable, no-clean fluxes. The time frame on this plan is to convert both facilities in Iowa to water washable materials and processes by 31 December 1996. A main obstacle is customer acceptance of this process. CACD's Inert Atmosphere Wave Soldering process qualification also established goals

to identify a low residue flux with fluxing performance equal to RMA flux, and to change from a CFC system to an aqueous cleaning system for removing residues with equal to or better than RMA soldered assemblies' cleanliness levels. The test methodology to be used was to meet MIL-STD-2000A, follow the Navy memorandum that adds additional tests, and to meet internal CACD requirements. Test results are shown in Table 3-3.

Table 3-3. Wave Soldering Process Qualification Test Result Summary

Test	*Process Requirement*	*Kester 951 Result*
SIR	$5x10^8$ ohms minimum	Vendor B24: $5x10^9$ ohms IPC B24: $1x10^{10}$ ohms CACD B24: $1x10^{12}$ ohms CACD B36: $1x10^9$ ohms
Corrosion	None allowed	QPL qualified flux
Halide content	None allowed	QPL qualified flux
Ionic cleanliness	10 µg/in² maximum	IPC: 8.0 µg/in² CACD: 1.33 µg/in²
Visual inspection	No electromigration allowed	None observed
Design of experiments investigation	Minimum number of defects	Optimum flux per design of experiments
Thermogravimetric Analysis	Minimum loss in Preheat Minimum loss at Wave	Optimum flux Optimum flux
Humidity	Individual component specification	No failures
Electrical	Individual component specification	No failures
Ion chromatography	Equivalent to RMA flux	Acceptable
Thermal cycling	Individual component specification	In progress (no failures to date)
Wetting balance	Equivalent to RMA flux	Acceptable
TSD Division data	Military production build	6 months of production with no reliability problems

Results

The test results met MIL-STD-2000A, Appendix A requirements as well as all other requirements; therefore, the wave soldering process was qualified. A total of 40 MIL-STD-2000A and 500 non-MIL-STD-2000A processes have been converted.

Solid Waste Environmental Leadership and Learning Team

Background

The Solid Waste Environmental Leadership and Learning Team at CACD has shown that being environmentally conscious does not result in expenses, but rather decreases costs by avoiding unneeded purchase of items, and reducing landfill costs. The team has spread its charter of developing, implementing, and championing recycling and reuse of solid waste. This effort includes recycling 19 items, reclaiming 15 others, and returning still others to the originating vendor. The results of the team's efforts can be shown in the solid waste reduction from 1992 to 1994 of 213,277 pounds.

Description

Paper products that cannot be recycled are chopped, mixed with coal, and burned at the power plant as fuel cubes. This process also reduces the emissions of burning high sulfur content coal. CACD contracts with Goodwill Industries to sort trash, and sort and return recyclables.

Results

An Environmental Recycling Cost Analysis of the Coralville operations highlights an annual expense of $63K with a benefit of over $104K, representing a net gain of more than $41K annual cost avoidance. Similarly, there is a reduction of ozone depleting chemicals such as those in Tables 3-4 and 3-5.

Table 3-4. Ozone Depleting Chemicals (Cedar Rapids)

	1991	*1992*	*1993*	*1994*	*1995*	*Total*
CFC-113						
Pounds Used (K)	55	46	42	24	0	167
Reduction 91-95		16%	24%	57%		
Methyl Chloroform *(1,1,1-TRI)*						
Pounds Used (K)	35	19	27	24	5*	110
Reduction 91-95		45%	22%	32%	86%	
*for 3 months						
Combined	90	65	69	48	5	277
Reduction, 91-95		**27%**	**23%**	**47%**	**95%**	

Table 3-5. Ozone Depleting Chemicals (Coralville)

	1989	1990	1991	1992	1993
Methyl Chloroform *(1,1,1-TRI)*					
Pounds Used (K)	32.2	23	18	16.7	13.9
Reduction, 89-93		**29%**	**62%**	**67%**	**80%**

Ozone Depleting Substance Alternatives Implementation Team

Background

An excellent example of how to make a team environment work to produce outstanding results is exemplified in this team's success. Their challenge was to eliminate ozone depleting substances from production processes and implement alternative materials and methods without impacting product quality or customer delivery performance.

Description

Working together efficiently and effectively enabled the team to overcome obstacles and solve problems. The results have been many. Products manufactured for our customers are in compliance with EPA regulations, and their has been a substantial reduction in chemical supply and disposal costs. Documents have been updated, audits conducted, and process conversions were completed by the federally mandated date, with zero production downtime.

Results

This cross-functional team, working closely with many material and equipment suppliers, accomplished major factory and production process conversions. This commitment to the environment continues for the future. The outcomes have benefited and will continue to benefit the customer, the company, and the environment.

Printed Circuit Wiring Board Etch Reuse

Background

Rockwell Collins, Inc. purchases 50,000 gallons of printed circuit board etchant material annually for use in the manufacturing of printed circuit boards. This material removes copper from circuit board laminates and places the copper in solution. The supplier of the etch has sub-contracted its recycle for many years through pricing contracts for the purchase of new/recycled materials. The etch is broken down into copper oxide (which is sold as a feed stock to smelters) and the remaining product is re-blended to create new/recycled etch for reuse in the facility. The only other alternative to this type of treatment has been to deep well inject the waste due to the ammonia content. This alternative is not within the waste hierarchy established by the EPA and Rockwell.

Description

Prior to May 1995, Rockwell Collins, Inc. recycled its printed circuit board etchant, but because of the way it was handled at the recycler it was still considered hazardous waste. The material was delivered to a recycler who transformed the spent etchant as described above which then sold the etch as a commercial product. In May 1995, a market was found that utilized printed circuit board etchants as a raw product in the manufacture of atacamite (an insoluble naturally occurring copper salt). This copper salt is an interesting replacement for animal feed nutrient supplements because of the insolubility it possesses in aqueous environments. The copper salt will not degrade over time resulting in lower dosing of feed blends and ultimately reducing the cost of the feed to the end user. In acidic solution (in the stomach of an animal), the copper salt is completely soluble and is readily absorbed by the animal resulting in superior performance over copper sulfate. The process has been approved under the use/reuse exemption requirements specified at Title 40 CFR Part 261. With this exemption, the etchant is no longer managed as hazardous waste and does not require a hazardous waste manifest to ship the product.

Results

By redefining the way the material is handled and no longer managing the material as hazardous waste, Rockwell, on an initial investment of less than $1,500, has reduced the generation of hazardous waste by over 450,000 pounds annually.

Paperless Work Flow for Electronic Maintenance Work Requests

Background

Rockwell CACD has developed a paperless work flow for electronic Maintenance Work Requests (MWRs). MWRs are used at CACD for tasks such as fixing lighting systems in conference rooms or moving office furniture. There are currently over 3700 MWRs per year at Rockwell, and more than half of these require attachments which are in-

structions or maps. Ninety to ninety-five percent of the MWRs require minimal documentation, and MWRs are not used for tracking cost, or time spent on the job.

Description

The manual MWR process, requiring a three to four day cycle time, involved completing four-page carbon forms, obtaining authorization, and hand carrying or delivering the request using the internal mail system. Therefore, CACD changed the manual process to a paperless electronic one in response to employee input, to reduce entry errors, promote clarity, reduce delays, and use available tools.

The paperless electronic process for MWRs uses a desk top computer to create and view MWRs, and the authorizing signature for these MWRs has been eliminated. Only front-end edits are allowed, and after the MWR has been sent for processing by the requester, it cannot be edited.

Results

There are many benefits to the electronic MWR. There is less paperwork, as the four-page carbon has been replaced by a single green sheet. There is also reduced paper handling and filing. CACD has eliminated replacing lost MWRs. The electronic MWR is a quicker system, resulting in a more responsive, satisfied customer. The status and history of any electronic MWR can be viewed on-line. The cycle time of an electronic MWR is one day less than that of a manual MWR. Finally, five to ten minutes per request is saved using the electronic MWR.

Sullivan Graphics - Marengo, IA

Strategic Scheduling

Background

In 1994 Sullivan Graphics - Marengo, Iowa was faced with serious capacity problems due to the seasonality of the newspaper insert printing market. Typically, every fall the insert market swells over capacity with the holiday sale ads that fill everyone's Sunday paper. As a result, customer/vendor relationships are often taxed to the limit by late deliveries, increased costs, and worker stress.

After a particularly difficult fall the previous year, Marengo was faced with losing several key accounts if its delivery performance did not improve. To improve deliveries, Marengo implemented an aggressive customer relation concept called "Strategic Scheduling." The initial step was to categorize customer accounts by their print frequency, ease of production, and profitability. The foundation of the job mix was the 63% of work that was produced on a weekly basis. These jobs were fit into fixed time slots along with bi-weekly preventative maintenance on each printing press. The remaining open time in the schedule was filled with national and regional work based primarily on profitability. In some cases, to fit jobs into the schedule required concessions on both Marengo's part and the customers. Since the impact of the resulting schedule affected other plants, the concept was proposed to the corporate management along with a list of accounts Marengo wanted to move, grow, shrink, and/or eliminate, to make it work.

Description

The aggressive handling of the customer base was done primarily to increase production and reduce late deliveries. However, during the preparation of the "sale" to the corporate office, Marengo began to realize the real opportunities for waste reduction that the proposed schedule changes would allow.

Increased	*Capacity*	*21.6%*
Reduced	*Job changeovers*	*45.0%*
Increased	*Run speeds*	*14.0%*
Reduced	*White Paper Waste*	*8.4%*
Reduced	*Printed Paper Waste*	*5.0%*
Reduced	*Press Wash Solvents*	*4.6%*
Reduced	*Waste Ink*	*63,450 # a year*
Reduced	*Aluminum Printing Plate*	*10,872 # a year*
Reduced	*Fountain Solution Mix*	*9,060 gals a yr.*

These improvements were realized without any capital improvements being made to the plant.

Results

Since the successful introduction of "Strategic Scheduling" in 1995, the Marengo plant has added an additional press line increasing its capacity by 22%. With this addition Marengo is facing open time in its schedule which does not allow the opportunity to fit work into its schedule as was done in 1995. As a result, Marengo has seen 50% of the gains from its original efforts reversed. Marengo anticipates that it will take almost a year to fill the plant to the previous capacity levels. At that time, Marengo will again apply "Strategic Scheduling" concepts, and anticipates that it will realize similar improvements. As customers and their needs change, this concept will have to be reapplied on a periodic basis.

Texas Instruments, DS&EG - Dallas, TX

Laser Cutting System

Background

Texas Instruments (TI) adapted a Laserdyne laser cutting system (Figure 3-9) to fabricate .020 to .050 inch aluminum thermal planes at Lemmon Avenue. These planes were previously cut by a chemical etching process, which had a number of disadvantages, including chemical waste, inconsistent quality, slow production rates, and relatively high cost.

Description

The Laserdyne system has a cutting velocity of up to 600 ipm using an 1800 watt peak power Coherent EFA-51 laser with an eddy current height sensor. The process has excellent repeatability, is comparatively inexpensive, and requires no unique hard tooling.

Results

Using this process, TI has achieved a 4 to 1 productivity improvement over the etch process. The current system produces over 40 thousand parts per year.

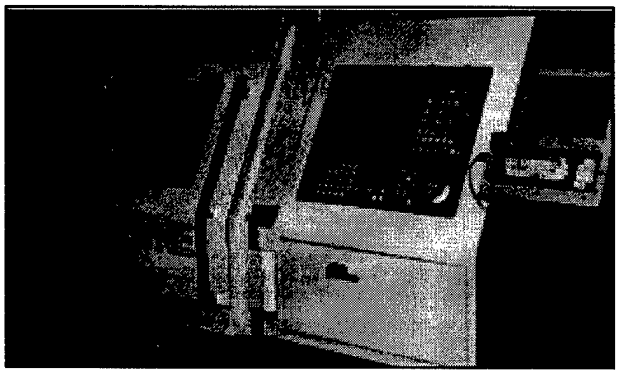


Figure 3-9. Laser Cutting System

Design for the Environment Initiative

Design for the Environment Initiative

A cornerstone element of DS&EG's strategy for the elimination and minimization of Hazardous Materials (HazMat) is its Design for the Environment (DFE) initiative, which was formally established in 1992. Because it was strongly felt that the design function needed to own the responsibility for the environmental attributed of a product and its associated life cycle processes, a strategic decision was made to initiative the DFE initiative from within the DS&EG.

To accomplish this, a DFE Champion has been designated to facilitate the development and integration of environmentally-conscious guidelines and practices on product and process development programs, and within engineering design and development processes. The DFE Champion serves as a liaison between the engineering design functions, DS&EG programs, and the environmental specialists. The DFE Champion has the advantage of understanding the design and product development processes, particularly to environmental attribute decisions. These decisions include, but are not limited to, process and material selections, design feature and configuration decisions and technology choices. This approach also benefits from an insider's understanding of the types and formats of information needed to accomplish environmentally-conscious design on a real-time basis in a concurrent engineering environment. Thus, DS&EG's Engineering Division owns and drives the DFE initiative.

DFE Guidelines Development

An important step in the DFE initiative was the formation of a cross-functional DS&EG DFE Rulebase Team. The core members of this team represent several engineering disciplines, as well as manufacturing and quality functions. Selection criteria for team members emphasized strong experience in the design process, as well as a good familiarity with manufacturing and other product life cycle processes. In developing the DS&EG DFE guidelines, the DFE Rulebase Team began by reviewing industry environmentally-conscious design standards compiled through a media search by the DFE champion. Using their own experience from previous product and process design efforts, the team identified the critical information and analysis needs for the effective and timely incorporation of Design for the Environment practices into the design process. For areas where information or recommendations gaps were identified, guidelines were expanded or revised to provide the design functions with needed guidance. The DS&EG DFE Rulebase now contains sections on Material and Process Selection, Design for Disassembly, Design for Recycling, Product Maintenance and Transport Considerations, and Energy Conservation.

DFE Trade Studies

The DFE Rulebase Team also recognized that the design function needed a standardized and documented methodology for evaluating the relative

environmental desirability of several potential design options. To fill this need, the team began work on a DFE Trade Study Process, and defined a hierarchical set of evaluation criteria and design questions for minimizing product and process life cycle environmental effects, while making necessary design tradeoffs against performance, costs, quality and speciality considerations. A trade study format has also been developed, which includes a tailorable trade study matrix worksheet, which can be modified to allow for differing decision making criteria and weighting values from application to application. Several specific trade study application worksheets for common design applications have been completed, and others are in work.

DFE Communication and Deployment

Both the DFE guidelines and the trade study process and tools have been made available to all design functions company-wide via an on-line electronic computer menu, as well as on an Intranet Web site. These resources contain a short tutorial on DFE drivers and principles, listings of contacts for additional information or questions.

Additionally, the DFE Rulebase Team has authored a series of awareness and communication articles which have appeared in several site newspapers, and in discipline and strategy specific newsletters throughout DS&EG. Further, briefings have also been issued to all program, project and design discipline managers on requirements and techniques to reduce Hazmat and eliminate ODS use.

The DFE Rulebase Team has also been able to incorporate the DFE guidelines and principles that it has developed into existing design training classes, further helping to reinforce the practice of simultaneously optimizing environmental considerations with other design parameters. Some of these same materials have also been integrated into the "Winning Designs" briefing developed and deployed to all TI designers worldwide. "Winning Designs" is an awareness briefing on environmental, safety and health concerns that may be related to design decisions. Also, DFE guidelines have integrated into several existing design guides.

DFE Design Process Integration

Another fundamental effort in the TI-DS&EG environmental stewardship initiative was the development and incorporation of product and process environmental assessment tasks into its established concurrent engineering methodology, the Integrated Product Development Process, or IPDP. The IPDP provides DS&EG programs with a time-phased roadmap of required tasks for product and process development and all later life cycle phases. The requirements for the execution of each task, including inputs, outputs, and metrics, risks, information resources, etc. are listed and communicated in order to ensure process completeness and quality, as well as to maximize effort synergy. The IPDP is executed by cross-functional Integrated Product Teams (IPTs) whose responsibility it is to simultaneously optimize the product and process designs for performance/functionally, coast, quality, schedule, safety and speciality requirements.

IPTs own, manage and report on all of their design performance requirements, generating and evaluating trade studies as required to guide them in material, process, technology and design feature selection. System or product level performance requirements include environmental considerations and are flowed down to sub-assembly or component level design efforts to be managed by the relevant IPT.

Execution of the IPDP covers all phases of a product's life; from its conceptualization through its design and production, and into its operations, support and disposition. TI-DS&EG recognizes that the decisions made during the execution of the IPDP for product and process development will ultimately determine life cycle material needs, process requirements, technology selection, energy usage and waste streams. As such, the IPDP becomes the ideal vehicle for the institutionalization of assessment and optimization of life cycle product and process environmental effects during the design and product management process.

To perform the integration of DFE and environmental related tasks into the IPDP, a multi-discipline team was created to review the existing design methodology and to compare it with the environmental assessment requirements from applicable of critical environmental evaluation tasks, deliverables and decision points was developed from the customer specifications and standards, accompanied by existing contract examples and known industry practices. The IPDP was then reviewed to determine the optimum placement in the product and process development methodology for these tasks.

Assessment tasks in the early phases of product development were strategically defined so as to provide needed information for later tasks, thus becoming building blocks. In this way, the specific environmental evaluation and decision-making information needed at the progressive phases of the product's design and later life cycle was proactively

and systematically identified and pulled forward to become the output of earlier analysis tasks, thus ensuring its availability when required.

As required, new task descriptions and process flowcharts were created or the existing descriptions and flowcharts were modified in order to achieve a comprehensive coverage of the environmental concerns over the entire product life cycle. This effort resulted in the generation and/or the modification of more than 35 product and process development tasks, along with associated flowcharts and deliverable descriptions in the IPDP. Product and process environmental decision-making tasks that were targeted for application of DFE practices include, but are not limited to, design reviews, parts and process selection, field testing, supplier management plans and requirements flowdown, packing/shipping, Hazmat management plans and demilitarization/disposition.

Additionally, environmental evaluation tasks, responsibilities and metrics have been incorporated into the discipline-specific design sub-process of the IPDP. This subprocess integration further enhances the active consideration of environmental requirements during the lower-level, detail engineering tasks.

Tinker Air Force Base - Oklahoma City, OK

Cadmium Strip Rejuvenation Process

Background

Although cadmium plating has been eliminated in the Oklahoma City-Air Logistics Center (OC-ALC) plating shop, there are still a great number of parts that must have old cadmium coatings removed. This process results in large amounts of cadmium contaminated strip solutions. To reduce this waste stream, a system was developed to rejuvenate the stripping solutions for reuse by selectively removing cadmium.

Description

The cadmium strip rejuvenation process uses an ion exchange column to selectively remove cadmium from contaminated strip solutions. A specially designed resin was developed that removes cadmium from the solution. When the resin can no longer remove cadmium, it can be rejuvenated with ammonia. The cadmium is then electrowinned (plated) from the ammonia solution. This pure cadmium can then be sold.

Results

This process allows the plating shop to reuse the stripping solution several times before disposal. When disposal is finally necessary, the solution will contain only trace amounts of cadmium making it less expensive to dispose. Finally by plating the cadmium out of the ammonia regeneration solution, the cadmium can be sold as a pure metal instead of disposed of as hazardous waste.

Carbon Dioxide Blast Booth

Background

CO_2 blasting is used to remove carbon, corrosion, and paint from jet engine components. In the past, these operations were accomplished by using solvents, acids, and caustics to chemically remove the material. This process required large vats of chemicals where parts would be soaked for several minutes to several hours.

Another use of CO_2 blasting is to replace traditional grit blasting. When grit blasting parts with internal cavities, it is necessary to mask the part to avoid grit entrapment. CO_2 blasting eliminates the need for masking, since the solid CO_2 sublimes to a gas upon impact.

Description

CO_2 blasting was installed in 1988, and is used primarily as a cleaning supplement. In this process, an operator works in an enclosed booth using a full face respirator by manually directing the CO_2 gun at the part. The gun propels CO_2 pellets at a high flow rate (8 pounds per minute). The cleaning is accomplished by the force of the impact which causes the solid CO_2 to sublime to a gas. The removed soils can then be collected. Smaller particles are removed from the air by a filtration system. Larger particles such as paint chips and carbon deposits are swept from the blast booth floor.

This process is used primarily for two purposes. The first is for spot or touch up cleaning. When a part is not completely cleaned in the chemical cleaning line, the CO_2 blast unit is used to clean the soiled area. This results in reduced chemical usage. It also allows the part to be processed faster, since it does not have to be reprocessed through the chemical cleaning line.

CO_2 blasting is also used in place of grit blasting on parts with internal cavities. Internal cavities must be masked before grit blasting to prevent grit entrapment which could cause damage to the engine. Since CO_2 sublimes from solid to gas, cleaning

can be accomplished without grit entrapment and without masking. This results in reduced hazardous waste from masking and quicker processing times.

Results

This process has resulted in reduced chemical usage and quicker processing times. CO_2 blasting has eliminated a total of 1,700 gallons of chemicals per year. These chemicals include methylene chloride, orthodichlorobenzene, cresylic acid, and caustic solutions. The hazardous waste disposal associated with these chemicals has also been eliminated.

High Velocity Oxy-Fuel Flame Spray

Background

High Velocity Oxy-Fuel Flame Spray (HVOF) is the newest generation high energy thermal spraying process. HVOF is currently approved for the application of wear/erosion coatings on exhaust nozzles, combustion chambers, and compressor blades. HVOF is currently being prototyped as a chrome replacement on a series of parts.

Description

The main advantage of HVOF over other thermal spray processes is the high impact speed that is obtained by the molten droplets of metal. This high impact speed produces very dense, hard coatings. Many of the properties of HVOF coatings are similar to that of chrome plate. In addition, HVOF coatings can be applied in approximately 45 minutes compared to over 48 hours for the same thickness of chrome. Waste water is virtually eliminated because there are no rinse waters involved. Finally, HVOF is very flexible because one machine is capable of applying over 23 different coatings. The properties of HVOF are being compared to the requirements of different parts to determine prototype candidates. These prototype parts will then be coated and tested in an engine to validate the new coating.

Results

This process allows the plating shop to reduce the amount of chrome plating that is done. It is hoped that HVOF will eliminate approximately 30% of the chrome plating work load. This reduction in chrome plating will also reduce waste water treatment and hazardous waste disposal.

Pressure Spray Washers

Background

Pressure spray washers are used for general parts cleaning and degreasing. The spray washers have been used to eliminate both perchloroethylene and Freon degreasers, PD-680 solvent cleaning, and some hand cleaning processes.

Description

Six pressure spray washers are currently in use. The washers are essentially very large "dishwashers" in which parts are loaded, the door is closed, and the switch is set to a preprogrammed cycle. The spray washers offer several advantages over conventional degreasing.

First, spray washers remove both grease and soils whereas a degreaser will only remove the oils. Second, the detergent is biodegradable and produces no organic vapors. The spent solution can be discharged to a waste water treatment facility instead of being disposed of as hazardous waste. Third, the spray washers eliminate worker exposure to solvent vapors making the workplace safer and more enjoyable. Finally, the spray washer technology is sustainable, because the biodegradable detergents will not compromise the environment for future generations.

The spray washers have successfully replaced perchloroethylene and Freon degreasing. It has also replaced some PD-680 solvent cleaning and hand solvent cleaning operations. In addition to meeting all the cleaning requirements of the previous processes, the pressure spray washers have also decreased process times and increased worker safety.

Results

The pressure spray washers have eliminated the use of 25,000 pounds per year of CFC-113, 220,000 pounds of perchloroethylene, and 8,000 pounds of PD-680. They have also resulted in quicker processing times and increased worker safety. Continued use of the pressure spray washers will identify additional uses which will result in less hazardous material usage and exposure.

Solvent Recycling System

Background

The Solvent Recycling System is used to distill solvent for reuse. The system allows the paint shop to use the solvent several times before final dis-

posal. The solvent, acetone, is used to clean the paint spray guns. In the past, the solvent was used until its cleaning ability was diminished. At that point, it was transferred to a barrel for disposal.

Description

One Solvent Recycling System is currently in operation. The system boils the solvent (acetone) under vacuum. The solvent vapor is then condensed resulting in a pure solvent that is suitable for reuse in the cleaning operation. The paint solids and sludge are then disposed of in barrels.

New solvent is added to maintain the solvent level. When the solvent is no longer adequately cleaned, the entire solvent bath is replaced.

Results

The Solvent Recycling System allows the solvent to be reused for over one month. Before implementation, the solvent was replaced on a weekly basis. This system allows the Paint Shop to use less chemicals and dispose of less hazardous waste.

Arc Spray

Background

Arc spray is used to deposit metal on jet engine parts and aircraft components. In the past, this operation was done by using nickel electroplating to deposit a layer of metal on the part. The new process decreases the processing time and provides a coating that has equivalent properties.

Description

Arc spray has allowed OC-ALC to eliminate half of the nickel plating work load from 1989 levels and its associated wastes. This process change was accomplished by challenging past practices. The Arc spray coating and nickel plate are not exactly the same, but the flame spray met all of the performance requirements for the application.

In addition to meeting performance requirements, the flame spray process produced less waste and required less time. A part can be coated with Arc spray in less than one hour, while plating normally takes several days. The only waste produced by the process is the water and metal sludge from the water fall duct collector. This is much less than the millions of gallons of nickel contaminated waste water that is generated from nickel plating.

Results

This process has resulted in reduced chemical usage, reduced waste generation, and quicker processing times. Arc spray has reduced the purchase of nickel by 11,400 lbs. The hazardous waste disposal associated with nickel plating has also been substantially reduced. Finally, the new process allows parts to be processed quicker reducing the cost and time of repairs.

Zinc-Nickel Alloy Plating

Background

Zinc-Nickel Plating is an environmentally acceptable alternative to cadmium. Cadmium was used in the past to provide sacrificial corrosion protection to steel and high strength steel. Cadmium is the most toxic chemical used in the plating shop and was therefore targeted for substitution. Cadmium tank plating has been eliminated through the use of zinc-nickel alloy plating, Ion Vapor Deposition of Aluminum (IVDAl), and cadmium brush plating.

Description

Zinc-Nickel Alloy Plating is currently in use as a replacement for cadmium plating. It offers three times the corrosion protection of cadmium and is more erosion resistant. Zinc-nickel plating has been used extensively in the automotive industry for many years, and recently this technology has been accepted by the aerospace industry as a replacement for cadmium and nickel cadmium coatings.

OC-ALC has been using zinc-nickel plating since 1991 resulting in a 25% reduction in cadmium plating. This process complements IVDAl, because it can be applied to all geometries including inside diameters.

Results

Technology transfer from the automotive industry identified zinc-nickel as an alternative process to cadmium. This process has resulted in a 25% reduction in cadmium plating and is a key process in the elimination of cadmium tank plating at OC-ALC. The elimination of cadmium tank plating also eliminated the cyanide associated with cadmium plating.

Water Jet Knife

Background

The Water Jet is used primarily to remove rubberized coatings from engine casings. It is also capable of stripping abradable thermal spray coatings, fiberglass, paint, sealants, adhesives, and aluminum vane wraps. Modifications to the system would allow it to strip virtually all thermal spray coatings.

In the past, rubberized coatings were removed from engine cases in a two-step process. First, the case was soaked in methylene chloride for several days. The case was then removed from the solvent, and the rubber was scraped away using a putty knife. Currently, thermal spray coatings are removed in a chemical process.

Description

Two Water Jets are currently in operation. The first is a small unit with a maximum part diameter of 36 inches. It was installed in 1987, and is operated by securing the part onto a turntable and manually directing the nozzle at the area to be stripped. The lid is then closed and the cycle is started. The machine delivers 10 gallons of water per minute at a pressure of 10,000 PSI. This unit is used to strip rubberized coating from engine cases and to remove aluminum vane wraps from the TF30 Inlet Guide Vanes.

The second machine, installed in 1993, is larger and uses robotics for nozzle placement. This machine operates at 20,000 PSI with a flow rate of 20 gallons per minute. The increased pressure allows a wider range of materials to be stripped, including abradable thermal spray coatings. Modifications to the system to allow operation between 30,000 and 50,000 PSI would add the ability to strip most thermal spray coatings. In this machine, the operator again secures the part to a turntable; however, the nozzle placement is computer controlled. The nozzle movements for each part can be programmed and saved for future use.

In both systems, the stripped materials are filtered from the waste stream. The water is then discharged to the Industrial Wastewater Treatment Plant. The Water Jet technology is patented by Mike Patry and Herb Barringer, OC-ALC engineers. The equipment is manufactured by Automaker.

Results

The Water Jets have eliminated the use of 2,360 gallons per year of methylene chloride. They have also resulted in quicker processing times and increased worker safety. The modification to allow higher operating pressure would further reduce hazardous chemical usage.

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Section 4

Waste Handling/Recycling/Reuse

Introduction

This section contains proven practices designed to reduce both hazardous and non-hazardous waste during the manufacturing process. Although non-hazardous waste is somewhat easier to identify and deal with, it no less presents serious challenges in terms of variety and magnitude. Hazardous waste, on the other hand, carries with it formidable and far reaching Federal, state, and local regulatory handling requirements. As stated in the Iowa Waste Reduction Center's pollution prevention guide, Congress defined the term "hazardous waste" in the Resource Conservation and Recovery Act as a solid waste, or combination of solid wastes which, because of its quantity, concentration, or physical, chemical, or infectious characteristics may:

- Cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness;
- Pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

Much of our industrial evolution can be tied to events in which the immediate need for a product allowed for short cuts or, in some cases, complete ignorance of the environmental impact. Over the past few years, more stringent environmental regulations, combined with a deep sense of respect for limited resources, have prompted overwhelming changes in waste handling practices in businesses, government agencies, and the academic communities. Not long ago, this waste was considered a necessary evil of the production process and was simply overlooked. Through education, reductions, reuse, reprocessing, redesign, rethinking, and substitutions, several very successful solutions are available in waste handling, recycling, and reuse practices.

If further information is needed, please feel free to contact the companies listed. These companies have dedicated a vast amount of time and resources to perfect these processes. If their dedication toward a healthier environment can assist in your efforts, then their goal of a cleaner legacy for future generations will be achieved.

Air Force Plant #44 Hughes Missile Systems Company - Tucson, AZ

Chemical Waste Minimization and Process Water Recycling

Background

As the result of the mandated closing of all surface impoundments at Air Force Plant #44 (AFP44) associated with process waste and waste water treatment, the need to minimize plating and surface finishing wastes and to conserve process rinse waters in general became critically important. A number of water recycling and waste minimization strategies have been implemented to date.

Description

Process rinse waters have been recycled at AFP44 for many years through the use of clarification, ultrafiltration and reverse osmosis technologies. Recent equipment upgrades and use of statistical process control has resulted in a consistently improved reclaimed water quality being sent back to the plantsite. One immediate benefit has been a decreased demand for the more costly deionized water in the process shops. In addition, the reclaim water now feeds the ion exchange units in the deionization area as it contains approximately 80% less total dissolved solids (TDS) than contained in city water. This has resulted in a less frequent requirement to regenerate the ion exchange resins with hydrochloric acid and sodium hydroxide which, in turn, has reduced even more chemical waste.

Additional water recycling has occurred in the General Plating Shop through the installation of ion exchange systems for all chrome and nickel plating rinse waters. Twenty gallons per minute of chromium and nickel ion loaded rinse waters are passed through separate cation and anion resin columns for complete removal of metal as well as deionization. The result has been less water entering the plantsite waste water stream and, more importantly, minimal chrome and nickel to treat by more costly methods downstream. The success of this effort has resulted in a second project to similarly remove copper, tin and lead ions from printed

wiring board process rinse waters at their source. Approximately thirty gallons per minute of redeionized water will be recycled back to the original processes.

In the area of chemical waste minimization, electroless copper plating which contains a very difficult to waste treat chelating agent EDTA has been eliminated. A new process utilizing a suspended graphite colloid to accomplish the metallization step has resulted in ease of chemical waste treatment and dramatically reduced rinse water requirements.

Acid recycling units are also being installed. Using a resin based technology, metals ions (copper, nickel, tin, lead, iron) will be removed from what are otherwise active acids resulting in near indefinite use of these process solutions.

Results

Reduction of chemical wastes being generated; reduction in overall water usage; lower operating costs; continued and, in some cases, improved product quality.

City of Chattanooga - Chattanooga, TN

Curbside Recycling Collection Program

Background

In support of its environmental and quality-of-life efforts, Chattanooga initiated a Curbside Recycling Collection Program in 1992 to provide residents with a curbside, pick-up recycling collection service. Collected materials are sorted, processed, and sold through a Materials Recovery Facility operated by Orange Grove Center, a sheltered workshop for the physically and mentally-challenged. This Material Recovery Facility was constructed using federal, state, and corporate contributions, and the Orange Grove Center will share the revenue with the City, which will also pay Orange Grove $3.00 per household per year.

Description

The program uses Dual Blue Bags as the primary containers for recyclable materials. One bag is used for co-mingled waste paper (newspaper, mixed paper, and cardboard). The second one is used for co-mingled waste containers (plastic bottles and jugs, glasses, bottles and jars, and metal cans). To accomplish the recyclable material pick-up, the City changed its policy from two garbage pick-ups each week to one garbage pick-up and one Dual Blue Bag recyclable pick-up. Residents acquire their own blue bags which are available free from certain area merchants, or purchased for two to ten cents each.

Results

The Curbside Recycling Collection Program averages 20% to 25% use per week, with some weeks peaking at 40%. As a result of this program, a 14% reduction in landfill is estimated to have resulted, and the Orange Grove Center can provide jobs for up to 100 mentally and physically-challenged clients; these jobs become part of their skill development program. The Orange Grove Connection helps motivate residents to participate in the recycling program, and provides continued educational opportunities and public awareness of the City's environmental agenda.

Warner Park Recycling Program

Background

The Warner Park Recycle Center is a city owned and operated facility that provides a full service, drop-off recycle facility conveniently accessible to Chattanooga residents and businesses. There was need for the center to develop a dynamic Outreach Program to encourage waste reduction, as well as a recycling and a Recycle Express Program to bridge the collection gap.

Description

Started in 1991, the Recycle Center at Warner Park accepts Type I and II plastics, aluminum can, lumber, recyclable paper, and glass and is manned and open six days a week. The facility collected 1,600 tons of recyclable material in 1995 which amounted to $100K in revenues from sale of the materials.

Besides providing a collection site for residents and businesses, the Center designed an Outreach Program to encourage and educate its citizens in waste reduction and recycling. This service includes providing speakers at various public and private functions, performing audits, and participating in school programs. Another program created by the Warner Park Recycle Center is the Recycle Express Program which the City provides as a special collection service for residents and businesses that lack the resources to deliver their materials to the drop-off facility. One major barrier to recycling is material collection, especially for businesses, non-profit agencies, and government activities. Many want to recycle but lack the re-

sources to deliver their materials to the drop-off facility. The Recycle Express Program was developed to bridge this collection gap. The City serves over 175 clients through this program including free material collection, a waste audit, program start-up assistance, and employee education. Clients provide their own collection containers and the City schedules pick-up to accommodate the individual client.

Results

The Warner Park Recycle Center's recycling activities are in compliance with the Tennessee Solid Waste Act of 1991. The Center has provided effective waste management services to its residents, reduced waste going to landfills, provided recycling opportunities to its residents, and developed and facilitated markets for its recyclable materials.

Department of Energy, Oak Ridge Operations - Oak Ridge, TN

Improved Handling of Recycled Materials

Background

The Oak Ridge Y-12 Plant is tasked to provide nuclear weapon dismantlement. This program has expanded substantially over the last two years, generating tremendous quantities of material for recycling. Existing recycle systems were initially inadequate and inefficient when the flow of returned materials increased by orders of magnitude.

In the recycled depleted uranium stream, this large flow of metal created new problems and exacerbated existing problems concerning employee health and safety, adequate storage of material, and disposal of waste products. Handling this material consisted of disassembly, placing the material into 55 gallon drums sent to the scrap processing area, then sending it to the warehouse for storage, and on to the foundry to cast into billets. Finally, the material was sent back to the warehouse for storage. Most of the drums proved inadequate and were crushed, scratched, or dropped during the awkward handling of the drums. The drums were then contaminated and had to be treated before disposal, adding another problem. In addition, a fire hazard associated with dumping uranium out of drums needed to be eliminated.

Description

The solution to these handling problems came by expanding the use of tote pans for all depleted uranium storage and handling. The tote pan (Figure 4-1) is a low, rectangular, heavy duty container with built-in forklift and stacking features and through further design enhancements also includes locking rings for the pan. Some pans were also made deeper. By using these tote pans, there has been minimized personal injury and fire hazards; the pans are easier to transport with a fork lift; are more efficient to stack and store; a greater visibility of contents which facilitates efficient packing and inventory ease; and the pans are more durable and totally reusable, thereby eliminating additional drum disposal.

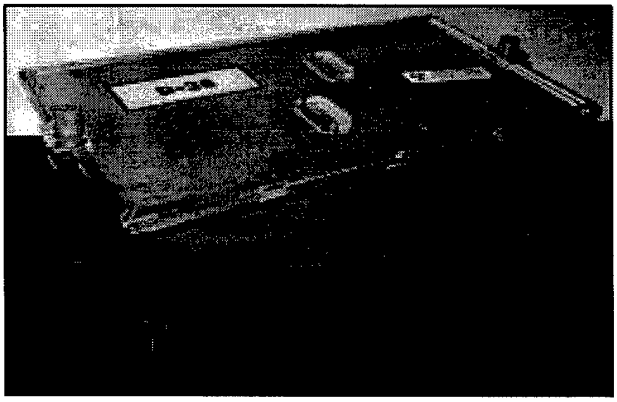


Figure 4-1. Tote Pan

An improved structured process flow was also implemented, routing all recycled depleted uranium to the scrap processing area where the proper storing and staging functions are performed. The filled totes are sent directly to the foundry, then on to the warehouse. This process flow eliminated an additional trip to the warehouse, thus decreasing the number of handling steps with resulting employee safety.

Results

Expanding the use of tote pans and the changes in the recycle process flow have corrected many problems in personal health and safety, reduced storage requirements for materials returned to the Y-12 Plant from weapon dismantlements, minimized a waste stream for contaminated 55 gallon drums, and resulted in more efficient recycling operations of depleted uranium.

In Situ Vitrification Method for Waste Disposal

Background

An extensive environmental restoration effort is underway at the DOE Oak Ridge Facilities. The objective of this effort is to develop and apply technologies that can provide data or remediate a site in situ, thereby averting the need to excavate, creating problems and expense related to worker exposure, environmental releases, and waste disposal issues.

Description

In Situ Vitrification (ISV) involves melting a disposal trench in place to produce a solid, relatively impermeable mass of glass and crystalline material encapsulating the wastes. This ISV process is achieved by placing a metal dome with four graphite electrodes into the trench and heating the trench to 1,500 degrees C, creating a man-made magna chamber melting the trench and the waste within the trench. The metal dome is placed over the melt to collect gases and particulates released from the melt. The collected off-gas is cooled, scrubbed, and filtered to remove any released materials before discharge. Once cooled, the matter vitrifies into a glass-like substance which can not be penetrated by ground water.

Results

This method is a cost effective means of removing small isolated areas of contamination/waste. There is low worker exposure to the waste and considerable monitoring of events in the chamber. This method has been conducted on a pilot scale at Oak Ridge National Laboratory (ORNL) and will be conducted on a real trench at ORNL in 1996. There are several characteristics of the ISV technology that offer attractive benefits to government and private applications including:

- Offering an advantage for radioactive sites since the airborne release pathway associated with excavation can be eliminated/minimized;
- Offering significant cost advantages for some sites compared to alternatives involving complex treatment trains made up of several technologies because of the ability of ISV to simultaneously process mixtures of radioactive and hazardous chemical-contaminated soil;
- Providing superior physical and chemical leaching properties of the glassy residual ISV product that is important for the safe, permanent immobilization of radioactive materials.

Resource Conservation and Recovery Act Closures

Background

Due to the requirements of the Resource Conservation and Recovery Act (RCRA), certain landfill and hazardous waste areas at the DOE-Oak Ridge Facilities had to be contained. Leaching was occurring from the buried wastes into the groundwater system through the numerous faulted rock layers, and therefore the means of preventing the surface water from penetrating the filled areas needed to be developed.

Description

The Oak Ridge Facilities personnel applied their extensive expertise in RCRA permits, containment, closure plans, and dealing with all of the regulatory requirements.

Areas as large as 90 acres had to be capped, and the solution that was developed was to contour the top surface into a berm shape. Two feet of clay was highly compacted to a permeability of 1x10-7 cm/sec. The clay was then covered with 30 mil poly vinylchloride (PVC) welded into one piece. A drain net with a filter on top was then placed on top of the PVC to allow the water to drain as much as possible before reaching the PVC in lieu of the normal one foot of sand. Two feet of earth was placed on top to provide for green cover growth (Figure 4-2).

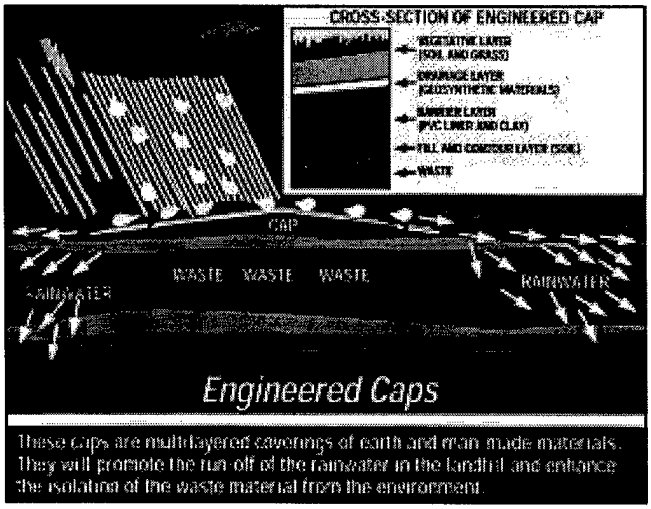


Figure 4-2. Engineered Caps

Results

This method has proven effective at stopping the leaching and could have wide application to many industrial and municipal landfill operations. Over 600 wells are in use at Oak Ridge for monitoring the leaching.

Spill Control System

Background

The Y-12 Plant at Oak Ridge employs a unique system to control any hazardous waste spill that may occur into the nearby East Fork Poplar Creek. The East Fork Poplar Creek runs through the Y-12 Plant, the Y-12 constructed "New Reality" pond, and eventually flows into the Clinch River.

Description

Actually a tertiary level of spill protection, this system operates only after the first and second levels of containment have failed. If necessary, the tertiary system uses a combination of creek surface skimming, spill containment, and creek diversion to prevent spilled materials from contaminating surface water systems.

As the first element of the tertiary control system, an oil skimmer has been installed immediately downstream from Y-12. The skimmer will remove spilled material floating on the creek surface. Unremoved surface contaminants and submerged contaminants not picked up by the skimmer flow into the New Reality Pond. In the event of a spill, the pond outflow can be shut off so that contaminated creek water can be contained. When the contaminated portion of the creek has been captured in the pond, creek entry to the pond is terminated, and the creek is diverted around the pond. The contained water can then be treated in the pond.

Results

The unique capability to divert the natural flow of East Fork Poplar Creek allows Y-12 to protect against surface water contamination which has previously been traced as far as Chattanooga. The diversion concept may be applicable to other large government and private industry sites, and the expertise of the system creators could benefit a variety of facilities with similar spill control challenges.

Sensor Development for Environmentally Relevant Species

Background

The ORNL needed a low cost, effective, and portable sensor apparatus to detect polychlorinated biphenyls (PCBs) in support of gasket and duct removal projects.

Description

ORNL and Michigan State University teamed and directed their collective resources to design, develop and build a modified surface acoustic wave (SAW) device whose frequency is selectively depressed by the absorption of PCBs. This technology provides an extremely sensitive technique to quantitatively measure PCB levels. The SAW device is manufactured in-house and has been applied in analysis of PCBs found in oil, sludge, water, and cement. Sample preparation and analysis is accomplished in seven minutes at a cost of $5 to $10 per test. Current price tests are $40 per test and produce potentially hazardous waste.

Results

As a result of this effort, additional benefits in the areas of non-selective polymers, functional polymers, polymer oxide glasses, and siliconization reagents were realized. This sensing device can also detect several other organic chemicals of interest in environment monitoring. A reduction of up to 75% of the extensive laboratory analysis can be eliminated by using the portable sensor apparatus. Techniques are continually being developed for concrete and rubber samples and to further increase the detection limit for PCBs.

Technology Logic Diagram

Background

The Technology Logic Diagram (TLD) integrates and cross references information about a site's environmental and waste management problems with analyses of technologies which can potentially be applied to solve the problems.

Description

The Oak Ridge TLD (available in hard copy and as a database) is expected to be a prototype for the development of TLDs for other DOE facilities. The TLD will provide a planning tool to assist in the selection of cost effective technology options.

For each environmental management (EM) activity, the logic path (Figure 4-3) flows through DOE goals, specific site problems and legal requirements to potentially applicable technologies. The status of each technology is described along with the scientific development needed to mature the technology, implementation needs, and cost. Each technology option is described in separate supporting volumes to the TLD. The diagram references points of contact who can provide detailed information on each technology. The TLD technique iden-

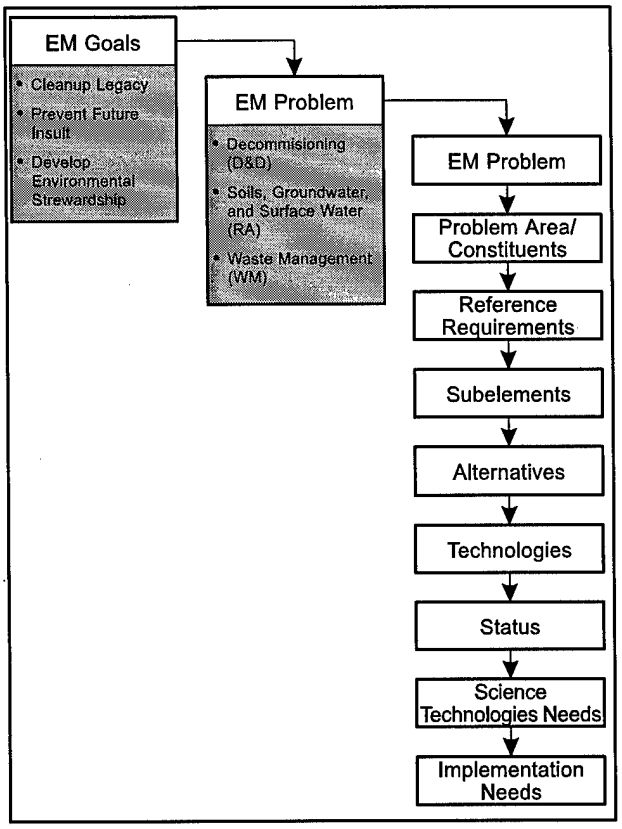


Figure 4-3. Technology Logic Diagram

tifies the research necessary to develop each technology to a state that allows for technology transfer and application to each EM activity.

Results

Use of this TLD provides several benefits to the DOE community, universities, and private industry. It identifies a host of technologies that can be used to solve environmental management problems. It acts as a vehicle to identify the deficiencies in technologies which otherwise would hold promise to speed remediation, allow safer project activities, and result in better, lower cost remediation efforts. Utilizing the TLD, improvements to existing technologies, demonstration of promising technologies, development of immature technologies, and support for fundamental technology investigations become options which can be explored to deploy the suite of technologies necessary for successful environmental management.

The TLD will aid in strategic planning, improved prioritization, and enhanced focus and leveraging of RDT&E efforts. Finally, the filtering aspects of the diagram that include regulatory drivers, technology costs and implementation needs allow the selection of technologies that will meet committed schedules and milestones.

Dover Air Force Base - Dover, DE

Dover Air Force Base as a National Test Site Groundwater and Soil Cleanup Testing

Background

The main challenges faced at Dover Air Force Base (DAFB) were a major environmental cleanup effort, reduced funds to accomplish the job, and resistance to using new technologies. Use of cleanup technology demonstrations, at the expense of the technology vendors, could resolve the first two problems but would run head on into the last challenge. This challenge could only be overcome by educating those opposed to using new technologies. This was not a one time effort. It required repeating the same message over and over until it began to sink through the shield of "It won't work at Dover." Another tactic to gain acceptance of new technologies was the implementation of small demonstrations that were out of the way, out of sight, and caused no long term impact.

Description

Three major demonstrations are fully implemented and a forth is nearing implementation. Five smaller demonstrations have been completed. The National Test Site has been approved with the first test cell in place and the first permitted controlled release complete. The test to cleanup the first release of JP-4 jet fuel and trichloroethene (TCE) solvent is underway. Other test cells are being planned with associated controlled releases. The second is planned to start the last of September 1996.

The cleanup of the largest groundwater solvent plume was estimated to cost $90 to $100 million using the best available, accepted technology. The current estimate for the cleanup of the plume after the demonstrations are complete is $5 million—to cleanup what the demonstrations do not finish off (using a less expensive technology proven by the demonstrations). The net savings is in excess of $85 million. Additional demonstrations are planned for the remaining contaminant plumes on base, which will increase savings.

Results

Benefits to DAFB include reduced cleanup costs due to better technologies, and reduced cleanup quantity necessary after the demonstrations.

Mason & Hanger Corporation - Middletown, IA

Barcode System for Hazardous Waste Management

Background

Mason & Hanger Corporation (M&H) procured a PC-based hardware and software system which provides automated control over the tracking of hazardous waste. The system utilizes bar coding for quick and accurate data entry. The system is able to track each hazardous waste container from the date of issuance to the date of shipment for disposal. Each inspection is recorded as well as the movement from generation to accumulation area to permitted storage area. It features an automatic tickler system for the 90 day and the one year storage areas. Various reports and analyses are available to the user. A complete history of each hazardous waste container is available to either a screen or printer. The manifest can be generated by the system at the time of shipment.

The facility is classed as a large quantity generator of hazardous waste. It has 6 permitted storage areas, 6 treatment areas, 14 accumulation areas, and 57 generation areas. All of these are spread throughout the 19,000 acre facility. Keeping track of each hazardous waste container was a monumental task. The paperwork was burdensome, and the chance for error or omission was very high.

Description

In an effort to relieve the situation, it was decided to explore the potential of a bar code system for resolving the issue. Finally a supplier was found with what appeared to be the answer to the problem. The basic system was sound and it could be easily fine tuned to M&H's particular method of operation.

Results

The system is now approaching full implementation. It has been modified a total of three times and now fully addresses the Company's needs. Since using the bar code tracking system, no container has exceeded its storage limits and no container has ever failed to be inspected on time. During a recent EPA Resource Conservation and Recovery Act (RCRA) compliance audit, a question concerning an inspection date was resolved with the historical information in the system.

The cost to implement such a system is in the $25,000 to $30,000 range and operating expenses are a minor cost factor.

Closed Loop Pink Water Treatment Facility

Background

Mason & Hanger Corporation performs high explosive melt loading operations for conventional ammunition items. As a result of these operations, explosive contaminated wastewater (pink water) is generated. In order to comply with the National Pollutant Discharge Elimination System (NPDES) permit limits for effluent discharge, the pink water is routed through a series of carbon filter columns prior to discharge into an on-site creek.

Description

This process requires close monitoring and analytical testing to assure that the permit discharge limits are not exceeded. To eliminate any chance of exceeding the discharge limits, Mason & Hanger Engineering designed a closed-loop system that utilizes the carbon treated wastewater as recycled process water.

This closed-loop system is fully operational at one site and will be implemented at two other sites in the facility within the next year.

Results

The immediate benefit of this system is that the discharge of treated explosive contaminated wastewater has been eliminated from this one outfall, thereby precluding the possibility of a NPDES permit violation. The environmental benefit is an annual reduction of 214,000 gallons of treated wastewater being released into the environment. This figure represents 37% of the installation's total for treated wastewater. This recycling process for pink water has also contributed to M&H receiving the 1995 Environmental Quality Award from the Department of the Army and the Honorable Mention Award for the Secretary of Defense's Environmental Security Award for 1995.

The cost to convert a pink water discharge system to a closed-loop system is a major expenditure. The operating expenses are less than a discharge system and there is a savings from the reduced usage of water. In this era of ever-tightening NPDES discharge limits, the closed-loop system is worth the expenditure in both peace of mind and environmental stewardship.

Millar Western Pulp (Meadow Lake) Ltd. - Saskatchewan, Canada

Elimination of Liquid Effluent

Background

One of the major challenges facing the pulp and paper industry is reducing the negative effects of liquid effluents on natural waterways. In the company's greenfield installation, which commenced operations in 1992, the problem of effluent discharge to waterways was decisively dealt with by construction of a zero liquid effluent discharge facility.

Description

There is no pipeline from the mill to any waterway - all of the process waste water is treated and 80% is recycled as distilled water for reuse in the process. The remaining 20% of the water is lost in the drying of the final pulp product, and by evaporation from effluent and treated water holding ponds.

Results

The effluent treatment sytem uses conventional evaporation, concentration and incineration unit operations to effect this significant accomplishment.

NASA Marshall Space Flight Center - Huntsville, AL

Environmental Control and Life Support Systems

Background

The Manned Habitat Environmental Control and Life Support Systems Test Facility supports Marshall Space Flight Center (MSFC)'s mission to develop and refine necessary processes and systems for environmental control and life support (ECLS) technologies. NASA relies on its Life Support Systems contractors — such as Boeing and United Technologies/Hamilton Standard — to provide the necessary environmental control systems. However, new and improved designs, and concepts and process theories continually evolve to refine, modify, and improve existing technologies.

Description

Originally formed to directly support the Space Station Freedom program, this 20,000-square foot highbay facility provides a hands-on testbed environment for ECLS technology development. A variety of full-scale working habitat simulators and contractor-supplied control systems provides the facility with a diverse range of ECLS systems capabilities.

Included within the ECLS facility are working simulation modules for wastewater collection and purification, atmospheric control and air recovery systems which control the oxygen pressures and levels, carbon dioxide removal/reduction systems, and smoke/fire detection systems. Individual ECLS subsystems have been integrated into a full scale habitat simulator measuring 15 feet in diameter and 40 feet long that is capable of operating at ambient and reduced pressures. This habitat simulator provides a self-enclosed ecosystem for testing and evaluation of the numerous environmental control systems required for life support.

The unique partnering agreements between MSFC and its Life Support Subsystem contractors has facilitated one of the most advanced systems development and integration laboratories in the world.

Experienced on-site contractors, working with MSFC personnel, provide an environment that facilitates personnel involvement through teamwork instead of working in a more traditional government/contractor relationship. This relationship provides the advantages of shared or free flowing information between parties while improving morale. Systems engineers and designers have used the facility to gain first hand, working knowledge of processes and integration issues. This effort allows them to return to the designing environment with enhanced knowledge of system requirements.

Results

This unique partnering has allowed MSFC personnel to gain invaluable knowledge into ECLS technologies and integration issues leading to advanced shipboard ECLS systems in a short time, and this knowledge will then be applied to the procurement process. Consequently, MSFC can ensure the procurement of what is needed with no time or money lost by reordering needed ECLS systems.

Nascote Industries, Inc. - Nashville, IL

Paint Sludge Recycling

Background

Nascote's paint lines included an overspray capture system which generated paint sludge, a material classified as hazardous waste by the EPA. Prior to 1993, paint sludge was collected and shipped in 55-gallon drums to a fuel blending facility and

burned, a process that still resulted in pollutants being released into the atmosphere. As costs increased with this process, Nascote began investigating alternative disposal methods to improve the environment and reduce costs.

Description

Nascote contracted with Environmental Purification Industries (EPI) of Toledo, Ohio to send paint sludge through EPI's paint waste recycling process.

EPI accepts paint waste under a highly-controlled procedure and processes it into a granular, inert powder which can be used as a filler or pigment for products used by the roofing, rubber, paint, plastics, and sealer/caulking industries. The new process reduces the chance of spills through bulk handling and shipping of the paint sludge. Strict record keeping and tracking procedures are followed by EPI who issues a recycling certificate verifying the waste has been completely recycled. This certification process complies with the Resource, Conservation, and Recovery Act for conserving energy and raw materials by recycling waste.

Results

Since 1993, over 5,000,000 pounds of paint sludge shipped to EPI from Nascote's paint overspray capture system has been recycled. In addition to eliminating 100% of the waste formerly discharged into the environment, Nascote's system reflected an annual disposal cost savings of approximately $100 thousand.

Naval Surface Warfare Center, Indian Head Division - Indian Head, MD

Solid Waste Recycling

Background

Source reduction is the Navy's top priority for solid waste diversion from landfills. It includes elimination, reuse, substitution, and minimization of products to reduce quantity of waste produced. The Navy's second priority in diverting waste from a landfill is recycling. Although recycling is not new to the management of solid waste, it is gaining wider acceptance as a viable approach to the solid management and disposal problems. If present refuse generation rates continue, the costs for disposal of solid waste will jump dramatically by the year 2000. State mandated recycling goals and increased public awareness are resulting in an increased amount of material being recovered for recycling. Although costs associated with recycling are increasing, recycling is considered to be a worthwhile solid waste management tool even at a net loss in order to conserve landfill space.

Navy policy requires all naval activities to develop and implement Solid Waste Management Plans. It is the essential tool for developing and maintaining a solid waste program that is in compliance with all Federal, State, and local regulations, and DOD/Navy instructions. The Indian Head Division's (IHDIV) Solid Waste Management Plan addresses the management of solid waste including a detailed description of its Recycling Program.

Description

The Resource Conservation and Recovery Act, Subtitle D, encourages solid waste management practices that promote environmentally sound disposal methods, maximize the reuse of recoverable resources, and foster resource conservation. The Maryland Recycling Act of 1988 establishes a requirement for Maryland counties to plan and implement a recycling system. Charles County has mandated a reduction of the county's solid waste stream by 15%.

Results

As a resident and also one of the largest businesses operating in Charles County, IHDIV is committed to an effective recycling program. In FY95, IHDIV recycled 30% of its solid waste, saving approximately $50,000 in disposal costs. Although IHDIV's recycling program is not a profitable one, it reduces solid waste going to the landfills, and saves money in disposal costs. The following materials are collected for recycling purposes at IHDIV:

Aluminum Cans	*Plastic*
Glass	*High-grade White Paper*
Cardboard	*Telephone Books*
Office Waste/Junk Mail	*Magazines*
Newspapers	*Tires*
Fluorescent Bulbs	*Laser Printer Cartridges*
Used Oil	*Antifreeze*
Lead-acid Batteries	*Scrap Metal*

A challenge for IHDIV continues to be education and awareness. To overcome this challenge, information on recycling is disseminated through articles and base-wide e-mail messages. Additionally, Departments are provided with the appropriate material necessary for recycling, such as white paper, office waste recycling boxes; desk-top convenience boxes; and beverage can recycling containers.

Photographic/X-ray Fixer Recycling

Background

Disposal of spent photographic and X-ray processing and printing solutions is expensive. The waste generated by these processes typically contains elevated concentrations of heavy metals, organic compounds, and other toxic constituents, unacceptable for direct discharge to a sewer system. There are, however, various technologies that can be applied to treat certain solutions prior to disposal and/or recover constituents of the waste streams which have value (e.g. silver recovery from specific photographic process wastes).

Description

The most concentrated silver-containing waste in film and image processing is spent or excess fixer bath solution. In a typical film developing operation, fixer solution is continuously added to maintain solution strength. As a result, there is generally an overflow of fixer from the bath. The concentration of silver in the overflow may vary greatly depending on type and amount of film processed. Because of this high silver concentration, silver recovery from the fixer solution is cost effective. Additionally, if this highly concentrated silver solution is disposed of, it would be a hazardous waste.

Results

The IHDIV has implemented an Electrolytic Silver Recovery System (ESRS) to recover silver from its photographic process wastes. The present ESRS is centrally located and requires transportation of spent fixer from the generation points. The fixer is processed until the recovery.

Trichloroethane Recycling

Background

Recycling is a viable alternative to single use/disposal of toxic solvents. It is environmentally benign, and reduces the amount of solvent purchased and disposed. Although capital, operating, and training costs are not negligible, most solvent recycling systems are less expensive to operate than the purchase of virgin solvent and disposal of spent solvent.

Description

In 1993, IHDIV purchased a solvent recovery distillation unit, or still. The still was not universal and could only distill low flammable solvents.

Results

The purchase of the still paid for itself almost immediately—a cost of $12,665 compared to the cost of one 55-gal drum of virgin Trichloroethane (Trich) at $1,992. Another savings for IHDIV is in disposal costs, which in the early 1990s was paying $0.22/pound. Currently, the only waste disposal cost is for the still bags contaminated with sludge after the Trich distillation is complete (Trich is used for degreasing metal parts).

Carbon Adsorption

Background

Wastewater discharge from energetics manufacture often leaves residual levels of nitrate esters in the effluent. To meet the regulatory effluent limit, IHDIV engaged in a vigorous project to construct seven facilities housing carbon adsorption treatment trains. The outstanding efforts of the engineers resulted in rapid transition through lab-scale testing to two subsequent pilot scale efforts of 4-inch and 10-inch columns, and then full scale testing of the actual carbon adsorption canisters. Within a short period, IHDIV had installed and commissioned carbon adsorption treatment trains which remove nitrate esters from wastewater from explosive and propellant production and processing plants.

Description

The current process successfully treats all wastewater from two nitrate production facilities which produce up to six different nitrate esters including nitroglycerin, propylene glycol dinitrate (PGDN), and others, and a propellant extrusion/machining operation which contains nitroglycerin. The carbon trains reduce nitrate concentrations as high as 6,000 ppm to nondetectable levels and treat up to 3 million gallons of wastewater annually.

Results

The most dangerous and persistent problem encountered in this process is the off-gassing of the contaminated carbon when fully loaded. This problem has been reduced by decreasing the loading on the carbon.

Ultraviolet Treatment of Contaminated Wastewater

Background

Traditional methods for treating industrial wastewater discharges from energetics manufacture leave residual levels of nitrate esters and volatile organic

compounds (VOCs) in the effluent. IHDIV studied the feasibility of using high intensity ultraviolet (UV) light, hydrogen peroxide, and ozone for the destruction of nitrate esters in wastewater. The goal of this study was to determine if the UV/ oxidation process is capable of decomposing each of the nitrate esters such that the residual level in the wastewater streams would be less than 1 ppm. Data indicated that in all wastewater streams the parent nitrate ester decomposed more effectively by UV hydrogen peroxide than by UV alone, reducing the nitrate ester concentration in wastewaters from 1,500 ppm to below 1ppm.

Description

IHDIV engineers and scientists designed and installed a full scale photo-oxidation process for removing nitrate esters: NG (nitroglycerin), PGDN (propylene glycol dinitrate), TEGDN (triethylene glycol dinitrate), and TMETN (trimethylolethane trinitrate), and other contaminants from process waste waters. The system uses UV light and hydrogen peroxide to destroy organic materials in the wastewater, and attains a destruction efficiency greater than 99.9%. The UV/oxidation wastewater treatment process for nitrate ester contaminated water provides an attractive alternative to other treatment methods for several reasons. It uses high-intensity UV light and a choice of oxidants, such as hydrogen peroxide or ozone, to decompose organic contaminants rather than removing and concentrating them on another medium which then must be treated.

The process consists of an automated, Programmable Logic Controlled (PLC) batch treatment system with four reactors. The reactors emit high-intensity (30 kw) UV light, and are used in combination with a hydrogen peroxide supply system, wastewater cooling tower, and automatic pH control to treat the process wastewater.

Results

Hydrogen peroxide in combination with UV light was the most cost effective system for most wastewater streams. For composite wastewater and wash water streams, the carbonates and bicarbonates had to be removed to receive the added benefit of hydrogen peroxide. UV/oxidation is potentially effective for treatment of nitrate esters wastewater streams, especially those where little or no salts are present.

Cost Comparison Summary

UV/Oxidation treatment is a less costly treatment than the Carbon Absorption:

Carbon: $246.48 per 1000 gal
UV/OX: $46.46 per 1000 gal

Naval Undersea Warfare Center Division - Keyport, WA

OTTO Fuel Reclamation

Background

With the rising cost of fuel and the increasing amount required for Torpedo launch and other uses, the Naval Undersea Warfare Center (NUWC) embarked on determining possible savings means keeping environmental and cost limits in mind.

Description

NUWC Division - Keyport has developed an OTTO fuel reclamation process that resulted in substantial savings for the facility. OTTO fuel, used in the external combustion cycle of the Mk 48 torpedo engine, is comprised of an energetic compound (Propylene Glycol Dinitrate), a desensitizer (Butyl Sebacate), and a stabilizer (2-Nitro DI Phenylamine). An OTTO fuel and seawater mixture is created during torpedo test firings by the addition of seawater into the fuel tank module. During a torpedo run, seawater is allowed to enter the fuel tank to pressurize the fuel, thus pushing it into the combustion chamber. OTTO fuel, which is heavier than water and with a different polarity, settles out at the bottom of the fuel tank. This chemical property of the mixture is used to aid in separating the mixture in a semiautomatic process.

The separation process begins by transferring the OTTO fuel and seawater mixture from the Mk 48 torpedoes to a separation tank equipped with low and high level fuel sensors. A quantity of the mixture is pumped into the separation tank and allowed to settle. After the mixture settles, a water overflow line is opened to transfer the seawater to a separate holding tank. Additional quantities of the mixture are transferred into the separation tank and the seawater is drained until the OTTO fuel level reaches the high level sensor. The high level sensor is located just below the seawater overflow so a minimum of seawater will remain on top of the OTTO fuel at this point. When the high level fuel sensor is reached, actuators shut off the influent mixture flow, shut off the seawater overflow, open the OTTO fuel drain valve, and introduce air into the separation tank to purge the fuel to a Grade B holding tank. The fuel level in the separation tank drops until the low fuel level sensors stop the purging operation and return the system valves to their original configuration. The location of the low fuel level sensor ensures that

only OTTO fuel is purged and a small quantity of fuel and the seawater above remain in the separation tank. The Grade B OTTO fuel is used to refuel torpedoes used for exercise drills only. Following the separation process, the seawater is treated by an activated carbon system and the Keyport Industrial Waste Treatment Facility before being discharged to the sewer.

Recent improvements to the process include the addition of an air dryer tank to further purify the Grade B OTTO fuel by sparging with air. After sparging and filtration, the Grade B OTTO fuel becomes Grade A and is used to fuel torpedoes for combat.

Results

The improved reclamation process has the capacity to process OTTO fuel and seawater mixtures from naval submarines in San Diego and Pearl Harbor that are shipped to Keyport in tanks. The process is also used to reclaim OTTO fuel from Mk 46 torpedoes.

A volume of 350,000 pounds of OTTO fuel, at a value of over $1M is being reclaimed at Keyport per year. Factoring in the costs to operate the process and the avoidance of waste disposal costs, the reclamation process results in a net savings of approximately $960K per year.

OxyChem - Niagara, NY

OxyChem's Niagara Plant Receives Beneficial Use Determination from New York State Department of Environmental Conservation

Background

Occidental Chemical's (OxyChem) Niagara Plant received a Beneficial Use Determination (BUD) from the New York State Department of Environmental Conservation (NYSDEC) for gypsum (calcium sulfate) produced in its chlor-alkali brine treatment operations. The BUD allows the plant to distribute this material as product for agricultural purposes in New York state.

Description

The success story began in 1992 when a multidisciplinary team was formed using personnel from Operations, Technical, Environmental, Purchasing, T&D, and Engineering with assistance from Corporate Environmental, and Grand Island R&D. The team sought to convert the 15,000 tons/year of dry gypsum filter cake to a beneficial use. Avoiding the need to landfill this waste would translate into a savings of over $500,000/year. The team discovered early on that Niagara's gypsum was virtually identical to commercial gypsum, thus leading to a potential agricultural use for the waste material.

Results

Testing over two years was conducted with the assistance of an agronomist (soil and crop specialist) on hay, ornamental shrubs, alfalfa, evergreen trees, and blueberries. The gypsum binds clay particles in soils, making it more porous and allowing water to permeate more freely. The material also proved effective in controlling ammonia odors from animal manure.

As part of the approval process with the state, a field visit to the test sites was conducted with representatives of NYSDEC, Cornell Cooperative Extension, NYS Department of Agriculture and Markets, the agronomist, and the Niagara Gypsum Team. State officials viewed first-hand the obvious benefits of gypsum addition to the soils and in dairy barn manure handling systems. The visit, combined with test reports, resulted in the BUD being issued within a week after the tour.

Pacific Northwest National Laboratory - Richland, WA

Recycling of Non-Hazardous Materials

Background

In 1994 and 1995, interest in reducing sanitary waste, demonstrating staff commitment to the environment, and practicing affirmative procurement led Pacific Northwest to initiate several recycling programs, including office products, used software, and toner cartridges.

In 1994, the office products recycling program only addressed white paper and aluminum. Small white paper recycling containers were placed in all offices and janitorial staff emptied them one day each week in lieu of emptying the trash. Aluminum cans were and are collected in central areas and considered part of the janitorial staff's property. In 1995 and 1996, the recycling program was expanded to include office paper, corrugated cardboard, mixed paper, newsprint, magazines, glass, plastic, tin, and aluminum. Due to a recent reduction in janitorial services, staff now empty their own recycling containers into the centrally located recycling bins. Staff are also encouraged to pur-

chase recycled products, especially white paper. Revenues received from the sale of office paper and cardboard are used to sustain the program.

Description

The used software recycling program returns obsolete software packages to Greendisk, Inc. Greendisk, Inc. recycles the paper from the manuals and the plastic, whenever possible, and degausses, reformats, and relabels the disks for resale. The blank disks are purchased by the staff to complete the recycling loop. The toner cartridge recycling program involves an exchange with toner cartridge vendors of used toner cartridges for a rebate on new cartridges. Pacific Northwest discovered that the quality of the new/rebuilt cartridges would determine whether or not staff would participate in this recycling program. An electronic buyer's guide for staff, the GreenGuide, instructs staff on the preferred vendors for recycled-content products.

Results

These waste-minimization activities save money through reduced disposal costs, staff time, and product costs. The estimated waste reduction is 95,250 kg per year. The initial implementation cost for these activities was $29,500 in 1995; no additional implementation costs have been incurred. The estimated cost savings for these waste-minimization activities was $198,000 in 1995 and is estimated at $223,000 per year for 1996 and beyond.

Recycling of Hazardous Materials and Operations Upgrades

Background

To decrease the quantity of waste disposal and its associated costs, maintenance and operations staff at Pacific Northwest implemented recycling programs for spent solvent, used oil, gel-cell batteries, lead-acid batteries, and toxic waste drums. Operations upgrades of vacuum pumps and a cooling system modification reduced the volume of wastewater disposal. The spent solvent recycling/reuse program, used by maintenance services painting operations, eliminated completely their solvent waste stream and their need to purchase new solvent. The used oil and battery recycling programs involve outside vendors picking up these items at no charge to Pacific Northwest. The toxic waste drums recycling program is actually a return of the used drums, once again at no charge to Pacific Northwest, to an affiliate of the chemical company from which the drums of chemicals were initially purchased.

Description

Previously, Pacific Northwest disposed of these drums as hazardous waste. The liquid ring vacuum pumps in one of Pacific Northwest's facilities created a continuous waste stream of 17 liters of wastewater per minute to the process sewer. Upgrading these vacuum pumps eliminated the need to discharge water to the process sewer, protecting it from potential contaminants in the laboratory vacuum-pump system. Another facility modifiedits cooling system critical compressors to allow recycled cooling rather than once-through. The compressors no longer require external water sources and instead use a chilled-water, closed-loop system.

Results

These waste minimization activities save money by reducing new-product purchases, disposal costs, waste management costs, and generation of mixed and hazardous waste, as well as the elimination of vacuum-pump wastewater discharge. The estimated waste reduction is 8.9 million kg per year of wastewater and 6,450 kg per year of hazardous waste. The initial implementation cost for these activities was $106,000; no additional implementation costs are expected. The estimated cost savings for these waste minimization activities is estimated at $146,850 per year.

In-line Solvent Recovery Systems

Background

Pacific Northwest has five in-line solvent recovery systems in operation in its research laboratories. They are used to recover and reuse solvent from laboratory analysis work.

Description

This waste minimization activity reduced the generation of hazardous and mixed low-level radioactive waste, decreased need to purchase solvents, and decreased waste management and waste disposal costs. The estimated waste reduction is 20 kg per year of hazardous waste and 7 kg per year of mixed low-level radioactive waste.

Results

The initial implementation cost was $21,600; no additional implementation costs have been incurred. The estimated cost savings for this waste-minimization activity is $18,000 per year.

Polaroid Corporation - Waltham, MA

Asbestos Management Council

Background

Many of Polaroid's buildings were built between 1962 and 1985, and those pre-dating 1975 were constructed with a variety of asbestos-containing materials. The Corporate Health, Safety, and Environmental (HSE) Office provided general guidance for managing asbestos-containing materials while each building's management was responsible for its own proper asbestos maintenance. In 1995, Polaroid established the Asbestos Management program to increase employee awareness and improve asbestos management at all its facilities.

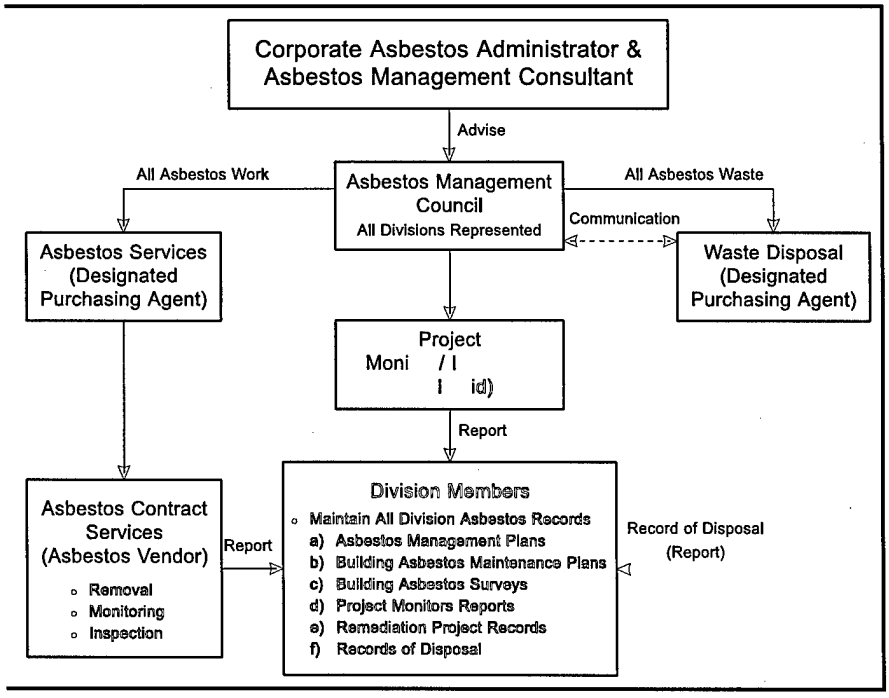
Description

Polaroid also created the Asbestos Management Council (AMC) to provide more guidance and establish ownership for proper, cost-effective asbestos management. AMC (Figure 4-4) includes participants from Corporate HSE, Purchasing, and Waste Disposal as well as Division representatives from all buildings containing asbestos materials. All AMC members have been trained (with several of them licensed) in proper asbestos management.

Results

Division representatives maintain all asbestos records associated with their buildings including asbestos management and building asbestos maintenance plans; building asbestos surveys; project monitoring reports; and remediation project and disposal records. AMC representatives also develop annual reports for their assigned location including asbestos removal projects summaries; sampling activities and results; building inspections; training activities; future asbestos-related activities plans; and customer satisfaction for asbestos abatement contractors. In addition, AMC has established a common process by developing various tools such as a list of required records, an asbestos awareness program, and a work notification form. These tools are available at Polaroid through AMC's Intranet website.

AMC meets quarterly to discuss issues and concerns, and to review the status on training and asbestos projects. Polaroid's Asbestos Management program has successfully established a common process throughout the company by providing guidance and creating ownership for proper, cost-effective asbestos management.



Electrostatic Discharge Machining Oil Removal

Background

Polaroid has developed a two-step carbon and clay filter system which removes oil and detergent from Electrostatic Discharge Machining operation wastewater. The system's initial objective was to maintain or reduce operating costs, and meet the sewer permit requirements set by the Massachusetts Water Resource Authority (MWRA). Acceptable wastewater standards call for less than 15 parts per million of total petroleum hydrocarbons.

Description

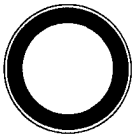
During the initial development phases of the project, Polaroid encountered some unique obstacles. Trial system #1 used a coalescing tank and carbon filtration media. However, the carbon media quickly clogged and required frequent and expensive changes. By adding clay to the filtration process, trial system #2 significantly improved the life

of the media. However, the wastewater discharge still continued the consumption of water during the process and represented a 5% chance of placing Polaroid in jeopardy for MWRA violations. Trial system #3 addressed the unforeseen benefit of using a closed loop method to run the discharge water back into the rinse tank. This system lowered capital costs, eliminated the possibility of MWRA violations, reduced water consumption by 2,300 gallons per day, and had the added benefit of eliminating wastewater sampling costs.

Results

Benefits from Polaroid's two-step carbon and clay filter system included decreasing water usage, reducing maintenance, and lowering the amounts of non-hazardous materials. Although it met the discharge standards with trial system #2, Polaroid chose to continue modifying and improving the filter system to the point of totally isolating the MWRA process regulations and eliminating the associated environmental liability.

Establishment of Chemical Categories



Background

Polaroid's Toxic Use and Waste Reduction (TUWR) program was voluntarily developed to reduce toxin use and waste sources as a means of preventing pollution. A critical element of the TUWR program was to assign environmental impact categories to the chemicals that Polaroid uses in its production lines. After evaluating each material based on toxic characteristics, physical attributes, and chemical properties, Polaroid assigns it to one of the following categories:

- I - known human carcinogens, teratogens, and toxic reproductive agents; highly acutely toxic; or a great environmental threat
- II - known animal carcinogens, teratogens, and toxic reproductive agents; chronic toxicity; or an environmental threat
- III - suspected animal carcinogens, moderately-toxic chemicals, or corrosive materials
- IV - chemicals that cannot be classified in I, II, or III
- V - other materials such as plastic, paper, and cardboard

Description

Based on this classification, Polaroid targets chemicals for either reduction (I and II) or recycling (III, IV, and V). As new chemical information becomes available, Polaroid evaluates and reclassifies its chemicals as appropriate. New chemicals are assessed before they can be introduced into production lines.

Results

Polaroid uses incentive plans to encourage the reduction of category I and II materials and the recycling of category III and IV materials in production lines. In addition, reduction and recycling goals are factored into each program manager's performance evaluations.

Although various regulations have established chemical lists, none meet the requirements of Polaroid. By comprehensively addressing and grouping chemicals specifically for its activities, Polaroid ensures that all its materials are included. Managers have a reliable and comprehensive source for identifying which chemicals should be eliminated and which can be managed through recycling.

Hazardous Waste Disposal Audit Procedure

Background

Polaroid recognized that various factors such as new technology, process changes, cost advantage, and vendor replacement can warrant a need for altering a waste stream's disposal method. To standardize the procedure, Polaroid developed an auditing process for determining the proper means of disposing hazardous waste and selecting vendors and proper treatment options. The auditing process includes a matrix that outlines the appropriate disposal methods for on-site recovery, fuel blend disposal, recycling sales, or disposal via a Treatment, Storage, and Disposal Facility (TSDF).

Description

The approval process begins with a meeting between Corporate Purchasing and HSE representatives to discuss financial, insurance, health, and safety issues. Next, an audit team consisting of Polaroid purchasing and environmental managers conducts a site visit at the TSDF to review labor relations, permits, site history, and other concerns. The audit team also inspects the site's operations and processes; reviews community relations; and interviews local regulatory agencies. After completing the site visit, Corporate Purchasing prepares a report which summarizes the audit findings and outlines the business reasons for approving the TSDF. Then an environmental team reviews the

report and makes a recommendation for approval or denial to the division that generates the waste.

Results

Corporate Purchasing monitors the business and environmental status of approved vendors by conducting follow-up audits within two years. Polaroid's Code of Conduct governs its procurement operations and states that "excellent health, safety, environmental, social, ethical, and legal standards must be met or exceeded in all sourcing activities by both the company and suppliers." These principles are also applied to all TSDF vendors and suppliers.

Through its unique auditing process, Polaroid has created a partnership between Corporate HSE, Corporate Purchasing, the divisions that generate the waste, vendors, and suppliers. This partnership ensures the continued protection of the environment and reduces the liability for Polaroid.

Landfill Avoidance

Background

In 1987, Polaroid's CEO, Mac Booth, made a commitment that his company would avoid sending chemical waste to landfills unless it truly was the best alternative. This decision was made prior to regulatory landfill-ban requirements. Additionally, the decision reflected concerns about the long term integrity of landfill storage and the potential for long term liability.

Description

To implement the CEO's initiative, Polaroid developed a landfill avoidance procedure. All hazardous waste disposal contracts must be reviewed by the Purchasing Environmental Manager at the corporate level. Spent hazardous waste which cannot be recycled, reclaimed, or reused in another process is sent to a chemical waste disposal facility as determined by the Purchasing Environmental Manager. If the manager identifies a waste product that cannot be cost-effectively handled by one of these alternatives, then an exception form is required (Figure 4-5). The exception form is completed by the vendor requesting the landfill option and reviewed for possible options by the Corporate environmental team.

Results

Polaroid's commitment to environmental responsibility has greatly reduced long term liabilities. In addition, Polaroid has created an environmental awareness throughout the company in all of its programs.

Profile # _____

Vendor _____

TSD LANDFILL REQUEST

Building _____ Date _____

Waste Stream Name _____

EPA Waste Codes _____

Reason why landfilling is more appropriate than other methods _____

_____

_____

Estimate of Total Organic Content in % _____

_____

Cost to landfill _____ $/drum, gaylord, 5-gal pail (specify)

_____ $/year based on estimated annual amount

Does material meet LDR prohibition levels (even if non-hazardous) **Yes/No**

Does landfill cost include treatment under LDR provisions **Yes/No**

Cost to incinerate (or other current practice - if so, specify)

_____ $/drum, gaylord, 5-gal pail

_____ $/year

_____

SIGNATURE

Figure 4-5. TSD Landfill Request

Cooling Tower Make-up Water Metering

Background

Typically, sewer charges for industrial sites are based on the percentage of cubic feet of water metered to a company's site regardless of its usage (e.g., drinking, cleaning, cooling). Water consumption charges are based on meter readings placed at an entry point to the site. Allowing for a small percentage for lawn watering, the Water Department calculates sewer charges from these same meter readings based on the assumption that water entering a site will exit the site through the sewer. In industrial sites such as Polaroid where film processing and machinery generate vast amounts of heat, large cooling towers are required to maintain stable temperatures and humidity levels. Although these cooling towers consume large amounts of water for operation, only about 10% of the water returns to the sewer system while the remaining

90% evaporates from the towers. As a result, Polaroid negotiated with the City of Waltham's Water Department for an annual rebate of sewer charges for the water which evaporates from its cooling towers.

Description

Until 1996, Polaroid paid full sewer charges for the evaporated water. Based on widely accepted engineering practices, on-site evaluations, and cooling tower blow-down cycles, Polaroid confirmed that an average of 90% of the water consumption volume for its 16 cooling towers evaporates, and the remaining 10% is discharged into the sanitation sewer system through the blow-down cycles. This breakdown equates to a 10:1 reduction of water consumed versus water entering the sewer system. Key to qualifying for the annual rebate was Polaroid's presentation and demonstration to the city that the Water Department's metering and sewer charging practices were inadequately reflecting the actual water discharged to the sewer system.

The city granted approval for the rebate, but required Polaroid to purchase and install new water meters at the intake of each of the water towers. The meters, which were compatible with the city's present metering system, registered in cubic feet and allowed for remote readout from a touchpad using a smart gun.

Results

By using the new method to estimate sewer discharge, Polaroid established a reliable accounting method for determining how much water evaporates at the cooling towers and how much enters the sewer system. Sewer charges are no longer based on the assumption that all water entering a site will be discharged through the sewer system. Polaroid's annual sewer charge rebate for its 16 cooling towers is estimated at $150,000 to $200,000 with a hardware implementation cost of less than $4,000.

Watershed Protection

Background

In the mid-1980s, Polaroid and the Waltham community became aware of the need for coordinated watershed planning and a program to reduce the potential for liability. Since Polaroid sits on a steep hill, runoff water flows directly into a drainage area adjacent to Route 128, a major commuting highway, and then into a drinking water reservoir. Polaroid had spill response plans for specific buildings at its facility, but no unified site plan to accommodate a spill which might flow beyond the boundaries of a building. In response, Polaroid developed a watershed protection plan for minimizing site spill risks to the community.

Polaroid initiated a hazardous materials team which established a coordinated site spill response plan. In the event of a site spill, Polaroid can close, within seconds, a 42-inch storm water valve in the site's drainage system which will prevent 60,000 gallons of runoff water from flowing into the community reservoir. If a spill occurs during a sustained heavy rainfall, the storm water valve and drainage system can contain the spill for two hours. Even in a worst-case scenario, the valve will provide enough time for Polaroid to respond to an incident without impacting the community.

Description

Polaroid improved the roadways around its site to provide multiple vehicular routes to its buildings and reduce the likelihood and impact of a transport vehicle spill. Other improvements include a holding bay to stage loaded trucks in inclement weather and a large storage tank to collect roof runoff water. The roof runoff water is then used for vacuum lines and cooling towers, eliminating the need to purchase water for this purpose. The Massachusetts Water Department has appreciated the steady discharge to the community water because it is now more manageable.

Another aspect of Polaroid's watershed protection program involves its community outreach efforts. These efforts include Polaroid's regular participation in the Waltham Earth Day festivities; assistance to the Cambridge Water Department by jointly developing informational brochures and hosting community meetings; voluntary stenciling of community water drains to discourage pollution; and open-line communication to the Massachusetts Water Department and the Waltham community.

Results

Polaroid has gained many benefits from its watershed protection plan and activities. The risk in handling a site spill is now minimal. Increased community awareness of the issues and the spill response plan characterizes Polaroid as a company concerned with the health and safety of its community. By partnering with the Cambridge Water Department, Polaroid has also established credibility with the authorities and a strong line of communication for resolving issues.

Rockwell Collins Avionics & Communications Division - Cedar Rapids, IA

Pay from Receipt

Background

CACD's new accounts payable process electronically matches the purchase order with the receiving document, and the system completely eliminates supplier invoices from the payment process. The Pay From Receipt (PFR) process is now standard for parts and material procurement at Rockwell CACD.

Description

Rockwell determined that most companies pay suppliers by matching the purchase order (what to buy) with the receiving document (what is received) with the invoice from the supplier (what is delivered). These documents address the same type of data, which leads to errors. It was determined that the supplier invoice added no value to the process, and therefore was eliminated. Without this function, the supplier did not need to submit invoices; CACD did not input invoices into a database, resolve problem invoices, or store invoices.

The PFR process was implemented in phases—each phase consisting of a selected number of suppliers. A brochure announcing the new PFR process to suppliers was created and distributed, and 1200 suppliers were added to the PFR process between April and July 1993. It was implemented for all production part suppliers by November 1993. Cost of implementation was $58K.

Results

This major business change has provided dramatic savings in administrative costs while maintaining timely payments to the supplier and the integrity of the procurement process. The Accounts Payable Department has been able to perform the new payment process with five employees instead of 15. The cost per document (including information systems cost) has been reduced from $8.00 to $3.00. The PFR process has placed CACD in-house accounting staff costs reductions at a world-class level in accordance with data reported in the Commercial/Government Accounting Function Cost Comparison study by Hackett, 1992, Journal of Accountancy, October, 1993.

United Defense, L.P., Ground Systems Division - Santa Clara, CA

Environmental Remediation - Remedial Cost Estimating

Background

Because of concern over remediation cost estimates that were consistently too low, which resulted in cost overruns averaging 40% in the industry, United Defense, L.P. Ground Systems Division (GSD) joined a consortium of approximately 200 companies and government facilities using the statistical model HazRisk.

Description

HazRisk has a database containing information on 237 actual, completed remedial site assessments, cleanups, and underground storage tank projects. This information is provided by the members of the consortium. HazRisk is operated by Independent Project Analysis, Inc. in Reston, Virginia.

By putting minimal amounts of current site data into HazRisk software, users like GSD can obtain accurate and defensible cost estimates based on the database site information already in the system. Since remedial costs generally run very high, corporate executives require accurate cost predictions. HazRisk not only makes cost predictions, but also quantifies the relative reliability of the current site data compared to the database sites, and it quantifies the probabilities for cost over/underruns.

Results

In using HazRisk, GSD has found the statistical model to be most useful in soil cleanup situations and least useful for complex sites with multiple environmental contaminants. This problem is typically solved by breaking the large, complex, multi-containment problem areas into small, less complex areas called operable units. Independent Project Analysis, Inc. has also found that the major cost driver in remediation projects is the volume of the contaminated media; the greater the volume, the greater the remediation costs.

Environmental Remediation - In-Situ Soil Treatment

Background

Soil remediation by excavation and off-site treatment is costly, time consuming, and interferes with normal site operations.

One area of concern to GSD is soil contaminated with petroleum hydrocarbons. Such soils have traditionally been excavated and disposed of as hazardous waste in hazardous waste landfills or remediated using technologies such as fixation, soil vapor extraction, or forced air bioremediation.

Description

In-situ soil treatment has been recognized as a viable alternative, and GSD has worked with its managing general partner, FMC Corporation, to test and develop a product called PermeOx. PermeOx has been developed to provide controlled release of oxygen in-situ which permeates throughout the substrata, enhancing the bioremediation process. A minimal amount of PermeOx produces optimum levels of oxygen in the soil.

Results

GSD recently tested PermeOx to determine its effectiveness at enhancing the natural bioremediation process. In the pilot study, GSD found by mixing PermeOx with petroleum hydrocarbon affected soil, an 85% to 90% reduction in total petroleum hydrocarbon (diesel) concentrations and 40% reductions in total recoverable petroleum hydrocarbon (hydraulic oil) concentrations. Using PermeOx instead of forced air bioremediation or typical soil vapor extraction, 40% cost reductions per ton of soil can potentially be realized.

Environmental Remediation Analysis, Computer Modeling, and Visualization

Background

Since 1985, internal research and development investments at GSD have focused on improving the communication between analyst and client in environmental clean-ups.

In the past, much of this analysis was done using tabular data and then visualized on typical two-dimensional plots and overhead slides. Regulators often applied default clean-up levels which were often overly conservative and costly. The regulators did not have the time and expertise to absorb the tremendous amount of information from computer modeling and risk assessment for site-specific proposals.

Description

Building on its experience using computer modeling and three-dimensional visualization for vehicle analysis, GSD has developed an interactive three-dimensional color graphics software called VIS3D, to integrate analysis with the environmental clean-up cycle (Figure 4-6).

The VIS3D software allows GSD to display and animate field data and/or modeling results in three dimensions. Realistic three-dimensional models of buildings, wells, roadways, and aquifers can be displayed to orient the analyst within the site. Animations of pollutant flows (plumes) can predict the spread of pollutants over long periods of time. Simulation models clearly illustrate the spread of pollutants over time taking into consideration rainfall and movements of underlying aquifers. This information can be viewed interactively on a computer terminal or be videotaped for viewing by GSD staff, government regulators, or court jurors. It gives the audience a three-dimensional visual understanding of what is happening at a given site. VIS3D can interactively cut, slice, and rotate the site for a better understanding of particular areas of a site. It can also calculate impacted soil volumes and perform threshold analyses to determine concentrations of contaminants through the site. Such information is valuable as input data to cost prediction statistical models.

Results

GSD's VIS3D package has been used to provide analytical services for many environmental clean-up clients.

These tools and services serve to: guide site investigations by improving pollution characterization and minimizing boreholes; guide remedial design through the development of more realistic remediations tailored to the site; negotiation of clean-up specifics with agencies and the public through understandable models which clarify ambiguities and alleviate regulator and public concerns; and use in litigation in place of charts to illustrate the nature of the pollution and clean-up problems to non-technical personnel.

GSD is continuing to develop this modeling technology through strategic alliances and Cooperative Research and Development Agreements with two western national laboratories.

Emergency Response Team

Background

Prior to the catastrophic earthquake that struck the area in 1989, there was little in place at GSD-O to respond to emergency situations in a coordinated fashion. The earthquake caused $21.4M in dam-

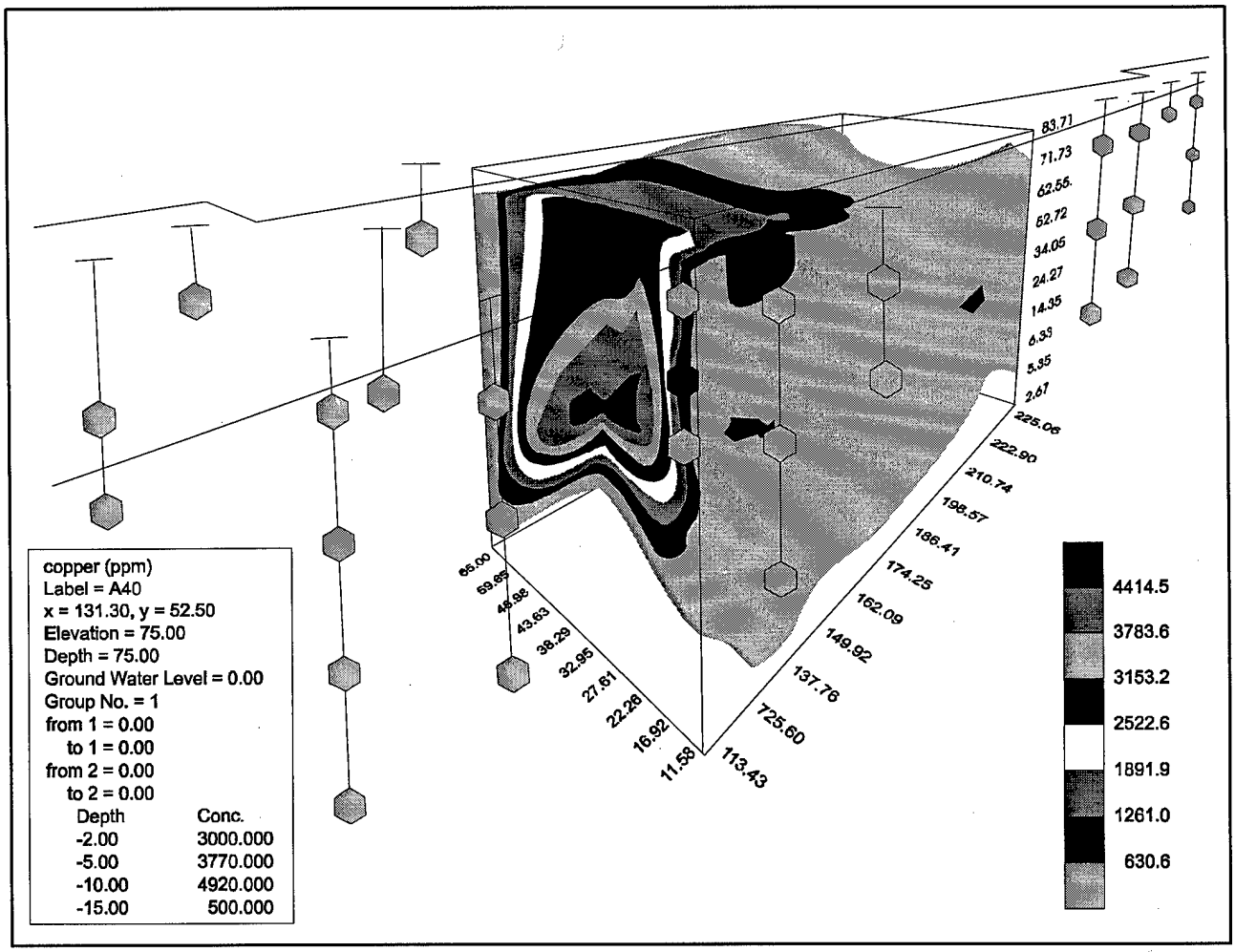


Figure 4-6. Example of Environmental Computer Modeling

age, including the loss of a major manufacturing building. This event, coupled with emerging legislation in the environmental area, led management to support creation of the Emergency Response Team (ERT) and the Crisis Management Team.

Description

United Defense, L.P., GSD-O has established a highly trained, well-equipped core of approximately 50 volunteer employees for its ERT. Team members are cross trained and certified to deal with chemical spills, incipient fire response, medical emergencies, and natural/industrial emergencies such as earthquakes, flooding, gas leaks, industrial accidents, and search and rescue.

Today, the ERT has well-stocked equipment lockers strategically located across the facilities. It also maintains a large commercial-type van that has been outfitted to carry a wide variety of equipment and supplies needed in the different emergency situations. All team members are equipped with pagers and can be called by security to respond to various levels of emergency. The intent is to provide rapid response to an emergency situation to prevent catastrophic results. The average response time is between 2 and 3.5 minutes. The team conducts periodic drills internally and in cooperation with outside agencies.

Results

Implementing and supporting this concept has resulted in a reduction of call-outs by 63% from 1990-1991, by 36% from 1991-1992, and by 34% from 1992-1993. The team has gained recognition by local and state Emergency Response agencies as well as gaining employee confidence in being capable of quickly responding to any emergency. This organized response has also reduced operational cost by avoiding costly downtime in containment of problems that could potentially stop work.

Appendix A

Table of Acronyms

Acronym	Definition
ACGIH	American Conference of Governmental and Industrial Hygienists
ADD	Actual Delivered Density
AE&CDP	Advanced Engineering and Core Design Process
AES	Autonetics Electronics Systems
AFP44	Air Force Plant #44
AIM	Automated Industrial Monitoring
AMC	Asbestos Management Council
ARACT	Alternate Reasonably Available Control Technology
AS&ASD	Autonetics Sensors and Aircraft Systems Division
ASHRAE	American Society of Heating, Refrigeration, and Air conditioning Engineers
BAWSS	By-product And Waste Search Service
BCTMP	Bleached Chemi-Thermo-Mechanical Pulp
BHTI	Bell Helicopter Textron, Inc.
BMP	Best Manufacturing Practices
BMPCOE	Best Manufacturing Practices Center Of Excellence
BTEX	Benzene, Toulene, Ethylbenzene, Xylene
BUD	Beneficial Use Determination
CAA	Clean Air Act
CACD	Collins Avionics and Communications Division
CC	Clear Choice
CERES	Coalition for Environmentally Responsible Economies
CFC 113	Chlorofluorocarbon-113
CMA	Chattanooga Manufacturers Association
CMS/CAS	Correctives-Measures and Cleanup-Alternatives Studies
CPED	Computational Physics and Engineering Division
CSR	Chemical Source Reduction
CSTA	Combat Systems Test Activity
CTD	Cumulative Trauma Disorder
dB	Decibel
DAFB	Dover Air Force Base
DCMC	Defense Contract Management Command
DEC	Digital Equipment Corporation
DED	Department of Economic Development
DFE	Design for Environment
DLA	Defense Logistics Agency
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DPI	Dayton Parts, Inc.
DWTP	Domestic Wastewater Treatment Plant

Acronym	Definition
E&M	Electronics and Missiles
EADC	Energy Analysis and Diagnostic Center
EARS	Environmental Accounting and Reporting System
EBMP	Environmental Best Manufacturing Practices
ECC	Environmental Control Center
ECLS	Environmental Control and Life Support
EIS	Environmental Impact Statement
EM	Environmental Management
EMD	Engineering Manufacturing Development
EPA	Environmental Protection Agency
EPI	Environmental Purification Industries
ER	Environmental Restoration
ERT	Emergency Response Team
ES&H	Environment, Safety, and Health
ESFR	Early Suppression Fast Response
ESP	Economy Surplus Power
ESRS	Electrolytic Silver Recovery System
FAA	Federal Aviation Administration
GIS	Geographic Information Systems
GSD	Ground Systems Division
GSS	GeoSpatial Support
HazMat	Hazardous Material
HAZCOM	Hazard Communication
HE	High Explosive
HRS	High Risk Situation
HSE	Health, Safety, and Environmental
HSEMC	Hamilton Standard Electronic Manufacturing Center
HVAC	Heating, Ventilating, and Air Conditioning
HVLP	High Volume Low Pressure
HVOF	High Velocity Oxy-Fuel Flame
HW	Hazardous Waste
IAAP	Iowa Army Ammunition Plant
IAQ	Indoor Air Quality
IC	Integrated Circuits
IEPA	Illinois Environmental Protection Agency
IHDIV	Indian Head Division
IPDP	Integrated Product Development Process
IPT	Integrated Product Team
IRA	Iowa Recycling Association
ISO	International Standards Organization
ISV	In Situ Vitrification
ITDS	Interactive Technology Distribution System
ITTD&E	ITT Defense and Electronics
IVDAl	Ion Vapor Deposition of Aluminum
IWE	Iowa Waste Exchange
IWRC	Iowa Waste Reduction Center
IWTP	Industrial Wastewater Treatment Plant

Acronym	Definition
JGAPP	Joint Group on Acquisition Pollution Prevention
JLC	Joint Logistics Commanders
JPPAB	Joint Pollution Prevention Advisory Board
JTP	Joint Test Protocol
LEPC	Local Emergency Planning Committees
LMTAS	Lockheed Martin Tactical Aircraft Systems
M&H	Mason & Hanger Corporation
MATURA	Massachusetts Toxic Use Reduction Act
MDA	McDonnell Douglas Aerospace
MEK	Methyl Ethyl Ketone
MPC	Materials and Process Characterization
MSD	Missile Systems Division
MSDS	Material Safety Data Sheet
MSFC	Marshall Space Flight Center
MTC	Manufacturing Technology Center
MWR	Maintenance Work Requests
MWRA	Massachusetts Water Resource Authority
NAVDEP	Naval Aviation Depot
NAVEODTECHDIV	Naval Explosive Ordnance Disposal Technology Division
NAVSCOLEOD	Naval Explosive Ordnance Disposal School
NG	Nitroglycerin
NIOSH	National Institute for Occupational Safety and Health
NO_x	Nitrogen Oxide
NPDES	National Pollutant Discharge Elimination System
NUWC	Naval Undersea Warfare Center
NYSDEC	New York State Department of Environmental Conservation
OC-ALC	Oklahoma City-Air Logistics Center
ODC	Ozone Depleting Compound/Ozone Depleting Chemical
ODS	Ozone Depleting Substance
OREIS	Oak Ridge Environmental Information System
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
OxyChem	Occidental Chemical
P2	Pollution Prevention
PaDER	Pennsylvania Department of Environmental Regulations
PCB	Polychlorinated Biphenyl
PCBTF	Parachlorobenzo-trifluorice
PDC	Professional Development Committee
PDP	Product Delivery Process
PEG	Polaroid Exposure Guideline
PEL	Permissible Exposure Limit
PFR	Pay From Receipt
PGDN	Propylene Glycol Dinitrate
PGDP	Portsmouth Gaseous Diffusion Plant
PHA	Process Hazard Analysis

Acronym	Definition
PLC	Programmable Logic Controller
PPM	Parts Per Million
PPOA	Pollution Prevention Opportunity Assessment
PPP	Pollution Prevention Program
PVC	Polyvinyl Chloride
PWB	Printed Wiring Board
QFD	Quality Function Deployment
RCRA	Resource Conservation and Recovery Act
RDD	Required Delivered Density
REECO	Regenerative Environmental Equipment Company
RET	Recommended Exposure Limit
ROSA™	Reduced Oxide Soldering Activation
RRTTC	Recycling Reuse Technology Transfer Center
RSI	Repetitive Strain Injury
RSSS	Remote Sensing Special Surveys
SAW	Surface Acoustic Wave
SERA	Sequential Electrochemical Reduction Analysis
SNL	Sandia National Laboratories
SRIP	Source Reduction Implementation Plan
STAR	Surface Technique and Research
SWELL	Solid Waste Environmental Leadership and Learning
SWSA4	Solid Waste Storeage Area 4
TAA	Total Assessment Audit
TDS	Total Dissolved Solids
TO	Technical Order
TCA	Trichloroethane
TCE	Trichloroethylene
TEGDN	Triethylene Glycol Dinitrate
TI	Texas Instruments
TIESYS	Texas Instruments Environmental Systems
TLD	Technology Logic Diagram
TMETN	Trimethylolethane Trinitrate
TSDF	Treatment, Storage, and Disposal Facility
TUWR	Toxic Use and Waste Reduction
TVA	Tennessee Valley Authority
USA	United States of America
UV	Ultraviolet
VAV	Variable Air Volume
VOC	Volatile Organic Compound
WAG4	Waste Area Grouping 4
WRAP	Waste Reduction Assistance Program

Appendix B

Where to Find Help

This section is a collaboration among the Environmental Protection Agency (EPA), Tennessee Valley Authority (TVA), and Rockwell Avionics & Communications, and contains the following information on where to find help for assistance on environmental issues:

- Web Sites
- EPA Summary of State Pollution Prevention Programs
- EPA Partners for the Environment
- TVA Summary of State Pollution Prevention Programs
- The University of Northern Iowa's Recycling Reuse Technology Transfer Center and Iowa Waste Reduction Center
- Environmental Programs for the State of Iowa
- Rockwell Avionics & Communications: Solid Waste Environmental Leadership and Learning Team

Web Sites

Army Acquisition Pollution Prevention Support Office

This web site contains links to the Joint Group on Acquisition Pollution Prevention (JG-APP). In accordance with JGAPP charter, the Joint Pollution Prevention Advisory Board (JPPAB) was formally chartered in 1995. The Advisory Board provides technical and programmatic support to the JGAPP and manages, coordinates, and executes the tasks in the JGAPP's Action Plan. Board members are responsible for coordinating all the activities within their respective services and for identifying required resources.

http://www.aappso.com/jgapp.html

Best Manufacturing Practices Center Of Excellence (BMPCOE)

The goal of the BMPCOE is to identify best practices being used in the areas of design, test, production, facilities, logistics, management, and environment, and to encourage industry and government to share information about these practices. To accomplish this goal, independent teams of government and industry experts have been established to survey organizations that are ready to share information about their own best processes. By fostering the sharing of information across industry lines, BMPCOE has become a resource in helping companies identify their weak areas and examine how other companies have improved similar situations.

http://www.bmpcoe.org

Design for Environment

The Design for Environment Website's focus is to provide resources for the design and production of environmentally friendly products. Topics include: design alternatives links (cadmium alternatives, chrome alternatives, ODC alternatives, and global warmer alternatives), pollution prevention links, recycling links, hazardous materials links (EPA's Top 20, EPA 33/50, hazardous air pollutants, Class I Ozone depleting substances, ATSDR, Regulatory resources, DFE conference announcements, and numerous other valuable internet resources.

http://www.flash.net/~rcade/dfe/index.htm

Division of Pollution Prevention and Environmental Assistance (DPPEA)

North Carolina Division of Pollution Prevention and Environmental Assistance (DPPEA); formerly North Carolina Office of Waste Reduction (OWR) Helping North Carolina.

http://www.owr.ehnr.state.nc.us

Eco-Cycle

Eco-Cycle believes in individual and community action to transform society's throw-away ethic into environmentally responsible stewardship. Its mission is to provide publicly-accountable recycling, conservation and education services, and to identify, explore and demonstrate the emerging frontiers of sustainable resource management—Reduce, Reuse, Recycle. Eco-Cycle is one of the oldest and is the largest of non-profit community recyclers in the U.S. Founded as a community-based grassroots organization in 1976, Eco-Cycle continues to promote a strong conservation ethic for Boulder County, CO. Community support and involvement are the keys to Eco-Cycle's success

http://www.ecocycle.org/

Energy Information Administration

Hundreds of links to other energy related sites such as Fuel Groups, Other Energy Groups, Special Features, and Customer Services. This is one of the most complete lists of energy links available.

http://eiainfo.eia.doe.gov/

Farm*A*Syst/Home*A*Syst

This voluntary program is a partnership between government and private business that enables individuals to prevent pollution on farms, ranches, and homes using confidential environmental assessments.

http://www.wisc.edu/farmasyst

International Journal of Environmentally Conscious Design and Manufacturing (ECD&M)

Introduces the rapidly evolving multidisciplinary field of industrial ecology, which seeks to understand how economic activities can be integrated with and have minimal impact on the surrounding natural systems.

http://ie.uwindsor.ca/ecdm_lab.html

Navy CFC & Halon Clearinghouse

The purpose of the Navy CFC & Halon Clearinghouse is to provide users of ozone-depleting substances (ODSs) with a central point of contact for information, data, and expertise on Navy ODS policy, EPA regulations, and alternative, chemicals, process, and equipment.

http://home.navisoft.com/navyzone/index.html

Office of Industrial Technologies (OIT)

OIT creates partnerships among industry, trade groups, government agencies, and other organizations to research, develop, and deliver advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial customers.

http://www.oti.doe.gov

Recycler's World

Recycler's World was established as a world wide trading site for information related to secondary or recyclable commodities, by-products, used and surplus items or materials.

http://www.recycle.net/recycle/index.html

Solvent Alternatives Guide (SAGE)

SAGE is a comprehensive guide designed to provide pollution prevention information on solvent and process alternatives for parts cleaning and degreasing.

http://www.clean.rti.org

The Utility Connection

The Utility Connection provides links to over 2,000 electric, gas, water, and wastewater utilities, utility associations, organizations, news, magazines, utility financial resources, and related state and federal regulatory and information sites.

http://www.magicnet.net/~metzler/index.html

The Small Business Assistance Program (SBAP)—General Information About the Program and Guiding Businesses Into Compliance With Environmental Programs

The SBAPof the Maryland Department of the Environment was created in April 1993 under the 1990 Clean Air Act to help small businesses comply with air quality programs. In July 1995, the SBAP underwent two significant changes. The program was incorporated in the Environmental Permits Service Center and its duties were expanded to provide small businesses with environmental compliance assistance for all media (air, water, and waste). The SBAP provides real-world help to small businesses both pro-actively (through outreach projects) and reactively (telephone hotline). Please call Linda Barker Moran, Program Manager, Small Business Assistance Program at (410) 631-3165 or (800) 433-1247 with your questions or comments.

http://www.mde.state.md.us/epsc/sbap.html

The Global Network (GNET)

This site is made possible by a cooperative agreement from the Federal Energy Technology Center (FETC) and the Department of Energy Office of Science and Technology (OST). GNET is a dynamic, communications and information delivery system that facilitates the rapid commercialization and diffusion of environmental technologies through public and private collaboration in the global marketplace.

http://www.gnet.org

United States Environmental/Recycling Hotline "Earth's 911"

The U.S. Environmental/Recycling Hotline puts geographically specific information at your fingertips nationwide. Locating this important environmental information and recycling centers "for all types of recyclables," is easier than ever before. Just type in your zip code and click away.

http://www.1800cleanup.org/index.htm

Best Manufacturing Practices in Environmental Management

The following environmental management links are sorted by category (i.e., Regulatory, Chemical Specific, Water, Land/Soil, Air Information, Hazardous Waste, etc.). Master World Wide Web sites provide a brief description and links to environmental information requirements and can be found beginning on page B-9.

Regulatory

1. ISO 14000
   The organization is in the process of developing environmental standards; search for news groups using this link.

2. Federal
   - The Code of Federal Regulations (CFR)
     A complete searchable test from the House Information Systems directly.
     Online help at **www.pls.com/plweb/info/help.oltoc.html**
   - Federal Register Available through websites, telnet, and limited e-mail; access to GPO and Unified Agendas databases through four university sites.
     - **www.okstate.edu/gpolink.html**
     - **thorplus.lib.purdue.edu/gpo**
     - **www.gpo.ucop.edu/**
     - **www.lib.utk.edu/gpo/GPOsearch.html**
   - U.S. Code, Bills, and Congressional Record
     Available via the web, gopher, and telnet; GPO provides the searchable accesses to seven databases via the university websites listed above under Federal Register.

- Title 40 CFR
  EPA established for the complete contents of the Title 40 CFR; searchable version is maintained by the National Environmental Information Service.
  www.virtulu.nvi.net/cgi-bin/webinator
- States
  Several states maintain their own Code of Regulations; currently, Indiana is not one of them.

Chemical Specific

1. EPA's Chemical Substances Database
   A database maintained by the University of Virginia on hundreds of chemicals.
   gopher://ecosys.drdr.Virginia.edu:70/11/library/gen/toxics

2. Agency for Toxic Substances Research's (ATSDR's) Hazdat database
   Substance-specific health effects information at
   http://atsdr1.atsdr.cdc.gov.8080/hazdat.html

3. Material Safety Data Sheet (MSDS)
   Searchable databases for hundreds of chemicals and manufacturers maintained by the University of Utah and Vermont SIRI, respectively.
   gopher://atlas.chem.utah.edu:70/11/MSDS
   http://hazard.com/msds

4. NTP's Abstracts of Toxicological Studies Database
   Online abstracts NTP reports on toxicology and carcinogens
   http://ntp-server.niehs.nih.gov/Main _pages/NTP_DOCS_PUBS.HTML

5. Right-to-Know Computer Network's (RTK NETs) New Jersey Fact Sheets
   Public access to the EPA's Toxic Release Information (TRI)
   telnet://198.3.148.6:23

6. Envirofacts Master Chemical Integrator (EMCI)
   Integrates varied chemical identification and cross references chemical data from four EPA databases using an internal Chemical Abstracts Service (CAS) registry number.
   http://www.epa.gov/enviro/html/emci/emci_overview.html

7. Water Resources Scientific Information Center (WRSIC) of the U.S. Geological Survey (USGS)—an international database collection of water research.
   http://www.uwin.siu.edu/databases/wrsic/

8. California's Department of Toxic Substances Control (DTSC)
   Information on waste management of chemical or mixture specific materials such as solvents, batteries, lead usage, pesticides, illuminating devices, lubricants, refrigerants, and others.
   http://www.calepa.cahwnet.gov/dtsc.html

9. California's Office of Environmental Health Hazard Assessment
   List of Proposition 65 chemicals (carcinogens or reproductive toxins).
   http://www.calepa.cahwnet.gov.ochha

10. Cal-EPA Chemical Cross Index
    Cross-index of chemicals and the programs under which those chemicals are regulated.
    http://www.calepa.cahwnet.gov/cci.htm

Water

1. EPA's Permit Compliance System (PCS)
   National system that contains National Pollutant Discharge Elimination System (NPDES) data and tracks permit issuance, permit limits, monitoring data, and enforcement actions.
   http://www.epa.gov/enviro/html/PCS/PCS overview

2. RTK NET's PCS database
   telnet://198.3.148.6:23

3. EPA's Office of Research and Development (ORD) BBS
   A text-searchable database of all ORD publications; no telnet address is currently available.

4. USGS's Water Use Data
   Data regarding water use is available.
   http://edcwww.cr.usgs.gov/glis/hyper/guide/1_250_lulc

5. USGS'S National Water Conditions
   Data regarding groundwater extremes, groundwater aquifers, stream water extremes, water quality, and selected reservoirs is available.
   http://nwcwww.er.usgs.gov:8080/NWC/

6. National Oceanographic Data Center (NODC)
   Site provides buoy information and information regarding marine toxic substances and pollutants.
   http://www.nodc.noaa.gov/

7. WRSIC of the USGS
   Selected Water Resources Abstracts international collection database
   http://www.uwin.siu.edu/databases/wrsic/index.html

8. EPA's Online Library System (OLS)
   Databases including its Clean Lakes database which contains citations and summaries on topics relating to lake management, protection, and restoration.
   telnet://epaibm.rtpnc.epa.gov

9. Environmental Guidance Documents
   Provides information on the following water issues: the Clean Water Act (CWA); the Safe Drinking Water Act; groundwater; and the Oil Pollution Act.
   http://www.tis.eh.doe.gov:80/docs/egm/links.html

10. Environmental News Groups
    Sources to find current discussions in a particular field and to find FAQs and pointers to web sites, mailing lists, and other resources
    - **http://news.sci.environment**
    - **http://news.sci.hydrology**
    - **http://news.sci.engr**

Land/Soil

1. USGS's Radon Database
   Information on the radon potential of rocks, soils, and water of the U.S. as a whole; more detailed radon risk assessments in specific geologic environments; and investigations of the correlations between geology and indoor radon; EPA radon publications are available at this website.
   http://www.epa.gov/RadonPubs

2. Water Resources Scientific Information Center (WRSIC)
   Selected Water Resources Abstracts
   http://www.uwin.siu.edu/databases/wrsic/

3. USGS's Land Use and Land Cover Data
   http://edcwww.cr.usgs.gov/

4. The National Oceanic and Atmospheric Agency's (NAA's) National Geophysical Data Center (NGDC)
   Manages environmental data in the fields of marine geology and geophysics, paleoclimatalogy, solar-terrestrial physics, solid earth geophysics, and glaciology (snow and ice).
   http://www.ngdc.noaa.gov/

5. Environmental Guidance Documents
   Provides guidance information regarding radiation protection and the oil pollution act.
   http://www.tis.eh.doe.gov:80/docs/egm/links.html

Air Information

1. Office of Air Quality Planning's (OAQP's) Technology Transfer Network
   Information exchange in different areas of air pollution control at eighteen BBSs.
   - **http://ttnwww.rtpnc.epa.gov/**
   - **telnet://ttnbbs.rtpnc.epa.gov**

2. AIRS Executive USA
   Database that contains a select subset of data extracted from the AIRS database.
   - **gopher://gopher.epa.gov (U.S. EPA's Gopher Server)**
   - **http://www.epa.gov/ (EPA's web server)**
   - **ftp://ftp.epa.gov (EPA's ftp site)**
   - **TTNBBS (EPA's electronic Bulletin Board System)**

3. Water Resources Scientific Information Center (WRSIC) Selected Water Resources Abstracts
   General air areas covered are meteorology, geophysics, energy, atmospheric technology, fluid mechanics, physics, climatology, and mathematical modeling.
   http://www.uwin.siu.edu/databases/wrsic/

4. NOAA's Data Set Catalog
   A forms-based tool that allows users to search for publicly available environmental data held by public and private sources.
   http://www.esdim.noaa.gov.NOAA-Catalog

5. The National Climactic Data Center (NCDC)
   The NCDC provides online data access to its data sets, including data inventories, long-term climatological data sets, U.S. monthly precipitation data, monthly temperature data, and special sensor microwave/imager data sets.
   http://www.esdim.noaa.gov

Hazardous Waste

1. EPA's Resource Conservation and Recovery Information System (RCRIS)
   RCRIS is primarily used to track handler permit or closure status, compliance with federal and state regulations, and cleanup activities. RCRIS contains data regarding handler names and addresses, hazardous waste categories and activities, owners and operators, and authorized waste handling methods.
   http://www.epa.gov/enviro/html/rcris/

2. RTK NET's Biennial reporting System (BRS) and NPL List
   Designed to provide easy public access to EPA's TRI information.
   telnet://198.3.148.6:23

3. Comprehensive Environmental Response, Compensation and Liability Information System
   Official repository for site-and non-site-specific Superfund data.
   http://www.epa.gov/enviro/html/cerlis

4. EPA's ATTIC
   ATTIC is a comprehensive automated bibliographic reference that integrates existing hazardous waste data into a unified, searchable resource.
   No address at this time

5. EPA's CLU-IN
   A publicly accessible, online computer system that fosters technology transfer and facilitates communication among those involved in solid and hazardous waste cleanup.
   http://clu-in.com

6. EPA's VISITT
   Database developed by EPA to provide current information about innovative technologies designed to remediate groundwater or nonaqueous phase liquids (NAPLs) in situ, and in soil, sludge, soil-matrix waste, natural sediments, and off-gas.
   telnet://clu-in.epa.gov

7. EPA's Vendor Facts Bulletin
   Designed to promote use of innovative technologies for field analytical techniques and site characterization.
   telnet://clu-in.epa.gov

8. WRSIC
   An international database collection of water research.
   http://www.uwin.siu.edu/databases/wrsic/

9. EPA's OLS
   Contains several databases including its Hazardous Waste Database, which contains citations and summaries of key materials on hazardous waste.
   telnet://epaibm.rtpnc.epa.gov

10. Environmental Guidance Documents
    A gopher site that provides guidance information regarding waste issues.
    http://www.tis.eh.doe.gov:80/docs/egm/links.html

11. DOT's HMIX Database
    HMIX BBS provides hazardous materials technical assistance and much more, but is limited to government employees.
    telnet://hmix.dis.anl.gov

Release and Risk

1. EPA's Emergency Release Notification System (ERNS)
   ERNS is a database used to store information on notification of oil discharges and hazardous substance releases.
   http://www.epa.gov/ERNS

2. RTK NET ERNS
   RTK NET is used mostly by environmental and public interest groups; designed to provide easy public access to EPA's toxic release inventory (TRI) information.
   telnet://198.3.148.6:23

3. EPA's Toxic Release Inventory Systems (TRIS)
   TRIS contains information about release and transfers of more than 300 toxic chemicals and compounds to the environment.
   http://www.epa.gov/enviro/html/tris/tris_overview.html

4. EPA's Center for Exposure Assessment Modeling (CEAM)
   CEAM serves as the focal point for ORD's multimedia assessment modeling, ecological risk assessment, and distribution of related software products; also provides a mailing list service.
   http://www.epa.gov/epa_ceam/wwwhtmlceamhome.htm

5. Hazardous Materials Mailing List
   This mailing list focuses on transportation, storage, and reporting of hazardous materials. To subscribe to this mailing list, send an e-mail message with the subject blank to following address.
   listserv@cc.colorado.edu

6. Environmental Training Mailing List
   This unmoderated mailing list covers all aspects of environmental training including needs assessments, selection of training topics, macro-designs, micro-designs, evaluation, follow up, impact assessment and project management. To subscribe to this mailing list, send an e-mail message with the subject blank to the following address.
   ListProc@Poniecki.Berkeley.edu

General Environmental Information

1. Environmental Agency Contacts
   Agency home pages that usually provide an organizational chart and/or list of names, addresses, and phone numbers of contacts; other resources are also referenced on the web.
   telnet://epaibm.rtpnc.epa.gov

2. Online Library Catalogs (OLCs)
   Most academic institutions and many large organizations now catalog their library holdings electronically. Many of these library catalogs are available online (though not necessarily through the Internet). Phoning the institution's library will generally allow you to determine if its holdings are accessible to the public and if it has an online catalog of its holdings.

3. Stanford University's Online Catalog (SOCRATES)
   SOCRATES catalogs all books and journals in the Stanford collection.
   telnet://Forsythetn.stanford.edu

4. EPA's OLS
   OLS's National Catalog provides citations and summaries of environmentally related topics encompassing biology, chemistry, ecology, and other basic sciences, and EPA reports distributed through the National Technical Information Service.
   telnet://Forsythetn.stanford.edu

5. EnviroFacts
   EnviroFacts is a compilation of EPA databases available via the web. EnviroFacts combines data extracted from four major EPA databases into a single, relational database. The databases that comprise EnviroFacts are: 1) Permit Compliance System, 2) RCRIS, 3) CERCLIS, and 4) TRIS. The databases also include FINDS and EMCI.
   http://www.epa.gov/enviro/html/ef_home.html

6. EPA's Facility Index System (FINDS)
   FINDS is a central inventory of facilities regulated or monitored by the different programs within the EPA. The system functions as a repository for facilities monitored by EPA, a repository of spatial data (i.e., latitude and longitude data) for these facilities, and as an integrator for facilities monitored by more than one program office.
   http://www.epa.gov/enviro/html/finds/find_overview.html

7. Environmental Guidance Documents
   Documents at this site provide guidance information regarding DoE comments, Environmental Surveys, Federal Facilities, General Information, Training, National Environmental Policy Act, and the Toxic Substances Control Act.
   http://www.tis.eh.doe.gov:80/docs/egm/links.html

Related Industry Links

1. American Trucking Industry
   The American Trucking Association covers everything, including safety, except environmental and engineering expertise.
   http://www.trucking.org/

2. Petroleum Business Directory
   A comprehensive listing of petroleum-related businesses categorized by state and business type.
   http://www.ipbd.com/ipbd

3. Engineering/Contractor Firms
   Some firms have groups that specialize in products and services in all aspects of the environment.
   http://www.blymyer.com

4. Law/Legal Firms
   Some firms have an environmental group that specializes in land use, natural resources, and most other areas of environmental law.
   http://mccutchen.com/env/eg_001.htm

Once linked to an environmental site, suggested keywords for narrowing the search are: appeals, approvals, arbitration, assessments, assistance, authorizations, claims, classifications, collections, compensation, conformations, criteria, definitions, designations, disclosures, emergencies, enforcement, exemptions, governing, grants, guidance, guidelines, hearings, implementations, information, judicial, liability, licenses, mandates, monitoring, notifications, organization, participation, penalties, permits, planning, policies, prevention, privacy, procedures, protection, publicity, records, registrations, regulation, reimbursements, reporting, reports, responsibilities, revocations, rules, secrecy, standards, terminologies, testing, and etc.

The following world wide web sites will provide most links and subsequent links to nearly all environmental information requirements.

1. The mission of the Agency for Toxic Substances and Disease Registry (ATSDR), as an agency of the U.S. Department of Health and Human Services, is to prevent exposure and adverse human health effects and diminished quality of life associated with exposure to hazardous substances from waste sites, unplanned releases, and other sources of pollution present in the environment. ATSDR is directed by congressional mandate to perform specific functions concerning the effect on public health of hazardous substances in the environment. These functions include public health assessment of waste sites, health consultations concerning specific hazardous substances, health surveillance and registries, response to emergency releases of hazardous substances, applied research in support of public health assessments, information development and dissemination, and education and training concerning hazardous substances.
   http://atsdr1.atsdr.cdc.gov.8080/hazdat.html

2. The Hazardous Waste Clean-up Information Web Site provides information about innovative treatment technologies to the hazardous waste remediation community. It describes programs, organizations, publications and other tools for federal and state personnel, consulting engineers, technology developers and vendors, remediation contractors, researchers, community groups, and individual citizens. The site was developed by the U.S. Environmental Protection Agency but is intended as a forum for all waste remediation stakeholders.
   http://clu-in.com

3. The Safety Information Resources on the Internet (SIRI) MSDS archive objective is to make critical safety information immediately and universally accessible with a few universal online archives which can provide a single source where any MSDS can be instantly located. Information from all manufacturers is accessible in a single index. All information in this archive is freely accessible; provides links to other MSDS sites.
   http://hazard.com/msds

4. News groups are a great place to find current discussions in a particular field and to find FAQs and pointers to web sites, mailing lists, and other resources. However most of the news groups are unmoderated, leading to a lot of noise (irrelevant messages).
   - **http://news:sci.engr**
   - **http://news.sci.environment**
   - **http://news.sci.hydrology**

5. Federal and State Regulatory Agencies use the National Toxology Program (NTP) study data in considering the need for regulation of specific chemicals to protect human health.
   http://ntp-server.niehs.nih.gov/

6. National water conditions linked from **http://www.usgs.gov**
   http://nwcwww.er.usgs.gov:8080/NWC/

7. TTN 2000 is information transfer born from the OAQPS Technology Transfer Network Bulletin Board System (TTN BBS), with the latest Internet information transfer tools. TTN 2000 fully connects the information resources of the TTN BBS with the entire world via the Internet. The true power of TTN 2000 lies in the fact that all the information is available from any connectivity option.
   http://ttnwww.rtpnc.epa.gov/

8. Blymyer Engineers is a nationwide environmental and industrial engineering firm with specialized experience in the transportation industry. In addition to providing full-service consulting services, they have developed products to assist the transportation industry in complying with storm water and other environmental regulations. Blymyer Engineers constantly track existing and upcoming environmental regulations and technologies. Blymyer Engineers Home Page is a single source for easy access to environmental information on the Internet. The primary purpose of this page is to provide corporate environmental managers with links to useful environmental databases in an organized, user-friendly format.
   http://www.blymer.com

9. This page presents interested parties with environment related documents and information provided by Cal/EPA and affiliated organizations. Sites linked through Cal/EPA are The Air Resources Board (ARB), the Department of Pesticide Regulation (DPR), the Department of Toxic Substances Control (DTSC), the Integrated Waste Management Board (IWMB), the Office of Environmental Health Hazard Assessment (OEHHA), and the State Water Resources Control Board (SWRC).
   http://www.calepa.cahwnet.gov/

10. Fifteen links to factual information in multiple formats plus new items, search capability, browsing, and feedback. For use by citizens, businesses, industries, educators, scientific communities, and established governing bodies. Can provide links to all aspects of environmental concerns. The fifteen links are:
    1) Concerned Citizens, 2) Business and Industry, 3) Students and Teachers, 4) Researchers and Scientists, 5) Kids, 6) State, Local, and Tribal Governments, 7) About EPA, 8) EPA News, 9) Offices, Labs, and Regions, 10) Regulations, 11) Contracts, Grants, and Financing, 12) Programs and Initiatives, 13) Publications, 14) Data Systems and Software, and 15) Information Services.
    http://www.epa.gov/

11. Seven links for concerned citizens are: 1) At Home and In the Garden, 2) Protecting Our Children, 3) At the Workplace, 4) On the Road, 5) Involved in the Community, 6) Thinking Globally, 7) Environmental Emergencies.
    http://www.epa.gov/epahome/citizen.htm

12. Three major links for teachers and students are: 1) Teachers and Students Curriculum Guides, 2) Facts about the Environment, and 3) Are Schools Environmentally Safe?
    http://www.epa.gov/epahome/students.htm

    Two major links with many sublinks are: 1) Fun Things, and 2) How You Can Help.
    http://www.epa.gov/epahome/kids.htm

13. Seven major links for business and industry are: 1) Programs & Initiatives for Business, 2) Small Business, 3) Partners for the Environment, 4) Regulations & Compliance, 5) Doing Business with EPA: Contracts & RFPs, 6) Publications, and 7) Data Systems & Software.
http://www.epa.gov/epahome/businesss.htm

14. Ten major links are: 1) Data Systems & Software, 2) Doing Business With EPA: Contracts & RFPs, 3) Environmental Test Methods & Guidelines, 4) Government Information Locator Service (GILS), 5) Grants and Fellowship Information, 6) Library Resources, 7) Offices, Regions, and Laboratories, 8) Regulatory Information, 9) Research Programs, and 10) Technical Documents.
http://www.epa.gov/epahome/research.htm

15. Four major links are: 1) Programs and Initiatives of Interest, 2) Financing for Governments, 3) Publications, and 4) Locations.
http://www.epa.gov/epahome/govts.htm

16. EPA's reinvention philosophy is to focus on improved environmental results. With one major link, the EPA's mission is presented: New Directions at the EPA.
http://www.epa.gov/epahome/epas.htm

17. Five major links for news and events are: 1) EPA Press Releases, 2) Announcements, 3) Speeches, 4) Newsletters, and 5) EPA Journal.
http://www.epa.gov/epahome/news.htm

18. Four major links for Offices, Regions, Laboratories, Programs and Initiatives are: 1) Offices, 2) Regions, 3) Laboratories, and 4) Programs and Initiatives.
http://www.epa.gov/epahome/Offices.htm

19. Four major links for rules and regulations are: 1) Federal Register - Daily Table of Contents, 2) Federal Register - Environmental Subset with Toxic Programs - Proposed Rules Subset, 3) Code of Federal Regulations (CFR) with the CFR Title 40-Environmental Protection (1995 Pilot) Subset with Office of Water Subset, and 4) United States Code.
http://www.epa.gov/epahome/rules.htm

20. Three major links for Contracts, Grants, and Financing are: 1) Contracts and RFP's, 2) Grants and Fellowships, and 3) Environmental Financing.
http://www.epa.gov/epahome/Finance.htm

21. Seven major links for Programs and Initiatives are: 1) General Interest, 2) Media Programs, 3) Industry Partnerships, 4) State, Tribal, and Local, 5) Geographic Focus, 6) Other Programs, and 7) Policy Statements and Strategy Documents.
http://www.epa.gov/epahome/Program.htm

22. The National Center for Environmental Publications and Information (NCEPI) is a central repository for all EPA documents. In addition to NCEPI, the EPA maintains numerous hotlines, which provide information on specific subjects. Agency dockets contain the public records of information used in the promulgation or revision of Agency rule making or policies. Docket files include Federal register notices, transcripts of public hearings, public comments, etc. EPA publications on this server are An Overview of the EPA Publications Numbering System and a listing of New Offerings. Links to other sources of EPA Publications are: EPA National Library Network Program, INFOTERRA, Education Resource Information Center (ERIC), Government Printing Office (GPO), FedWorld/National Technical Information Service (NTIS), and the Environmental Technology Gateway.
http://www.epa.gov/ncepihom/index.htm

23. EPA has a variety of database systems available for use in understanding the environment. They are: 1) AIRS - Aerometric Information Retrieval System, 2) Ecoplaces, 3) Emergency Response Notification System (ERNS), 4) Envirofacts with several sublinks (AIRS/AFS, CERCLIS, PCS, RCRIS, and TRIS), 5) Environmental Indicators Home Page, 6) Enviroene, 7) Geospatial Data Clearinghouse, 8) Great Lakes Information Network, 9) Great lakes Regional Information System, 10) Hazardous Waste Data, 11) Municipal Solid Waste Fact Book, 12) National GIS Program, 13) Reporting on Municipal Solid Waste: A Local Issue, and 14) STOrage and RETrieval System for Water and Biological Monitoring Data (STORET). In addition to maintaining information, there is software available from EPA to monitor and protect the environment. They are: 1) AIRS Executive Software, 2) Atmospheric Pollution Prevention Division Software Tools, 3) Center for Exposure Assessment Modeling (FTP site), 4) Center for Subsurface Modeling Support, 5) ECOTOX Threshold Software, 6) EPA's Information Systems Inventory (ISI), 7) EPANET, 8) Four available under Office of Science and Technology, 9) Software for Environmental Awareness, 10) Vehicle and Engine Emission Modeling Software, 11) Water Radioactivity Software, and 12) Freely Available Utilities.
http://www.epa.gov/epahome/Data.htm

24. Information Services and Tools has thirteen sublinks: 1) Clearinghouses, 2) Dockets, 3) Hotlines, 4) Information Centers, 5) International Information Services, 6) Library Resources, 7) Bulletin Board Systems, 8) Data System and Software, 9) Models, 10) Publications (NCEPI), 11) Test Methods & Guidelines, 12) Access EPA, and 13) Government Information Locator Service (GILS).
http://www.epa.gov/epahome/finding.htm

25. National Oceanic and Atmospheric Administration Environmental Information Services provides data products and links to meteorology/weather, archived data, information about organizations, on-line systems, data sets, and other products available from other NOAA data providers. The National Environmental Data Index (NEDI) provides direct access to environmental data information descriptions held at many locations. It allows full-text searching of these environmental metadata using WAIS search software and the Z39.50 protocol to communicate over the Internet. The overall goal of NEDI is to identify the widest possible range of environmental data and information and thereby facilitate their use by citizens, industry, government, and academia. NEDI is a core element of the National Information Infrastructure (NII).
http://www.esdim.noaa.gov

26. Public access is available through the Federal Depository Library, or directly from GPO. Access, a service of the U.S. Government Printing Office (GPO) provide The Federal register, Congressional Record, Congressional bills and other Federal Government information via GPO. Links to documents in GPO WAIS databases are provided. Connection to the Online Databases permits searches via Government Information Locator Service (GILS) Records, the Monthly Catalog of U.S. Government Publications (MOCAT, the Federal Bulletin Board (FBB)), Information on Demand from U.S. Fax Watch, the Federal Depository Library Gateway, the Access Federal Locator Services, and the On-Demand Delivery Services.
http://www.access.gpo.gov/

27. McCutchen, Doyle, Brown & Enersen, LLP is a full-service law firm specializing in securities litigation, product liability, torts, insurance, environmental litigation, commercial litigation, intellectual property, health care, and appellate practice. A leader in agribuisness law and environmental and natural resources practices. The environmental attorneys focus on legislative and regulatory issues and litigation for clients in waste management matters, hazardous substance litigation, air and water quality matters, and the regulation of hazardous materials. We assist clients in conducting internal reviews of their own compliance status, as well as both full-scale and target environmental review in connection with mergers and acquisitions, and real estate transactions and financings. A natural extension of their environmental and agribusiness practices has been the development of other specialized practice groups in food and drug and biotechnology law.
http://www.mccutchen.com/env/eg_001.htm

28. DOE's Environment, Safety and Health (ES&H) Technical Information Services (TIS) is a collection of information services that provides safety and health professionals with reliable, accurate and current information. The Office of Information Management combines information technology and services. Through the ES&H Info Center, an experienced research staff provides multi-media access to federal, industry and international information sources.
http://www.tis.eh.doe.gov:80/tis.html

29. All the information needed from ATA are available at this site for safety in transportation using over-the-road haulers.
http://wwww.trucking.org/

30. The agency provides the systematic and scientific "classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain" for geologic, topographic and hydrologic information and promotes the health, safety, and well-being of the people. This information consists of maps, databases, and descriptions and analyses of the water, energy, and mineral resources, land surface, underlying geologic structure, natural hazards, and dynamic processes of the earth. Provides information in many forms to the public to predict, prevent, and mitigate the effects of natural hazards. USGS activities in the environment theme area include studies of natural processes and of the results of human actions; the goal is to provide the understanding and scientific information needed to recognize and mitigate adverse impacts and to sustain the environment.
http://www.usgs.gov

31. The Earth Resources Observation Systems (EROS) Data Center (EDC) is a data management, systems development, and research field center of the U.S. Geological Survey's National Mapping Division. There are over 250,000 products to scientists and resource managers around the world to support scientific studies, resource management and environmental monitoring activities world-wide.
http://edcwww.cr.usgs.gov/

32. The Land Use and Land Cover (LULC) data files describe the vegetation, water, natural surface, and cultural features on the land surface. The USGS provides these data sets and associated maps as a part of its National Mapping Program. The LULC mapping program is designed so that standard topo graphic maps of a scale of 1:250,000 can be used for compilation and organization of the land use and land cover data.
http://edcwww.cr.usgs.gov/glis/hyper/guide/1_250_lulc

http://www.ngdc.noaa.gov/

http://www.nodc.noaa.gov/

http://www.okstate.edu/gpolink.html

http://www.pls.com/plweb/info/help.oltoc.html

http://www.tis.eh.doe.gov:80/docs/egm/links.html

http://www.trucking.org/

http://www.uwin.siu.edu/databases/wrsic/

http://www.uwin.siu.edu/databases/wrsic/index.html

http://www.virtula.nvi.net/cgi-bin/webinator

telnet://198.3.148.6:23

telnet://clu-in.epa.gov

telnet://epaibm.rtpnc.epa.gov

telnet://Forsythetn.stanford.edu

telnet://hmix.dis.anl.gov

telnet://ttnbbs.rtpnc.epa.gov

thorplus.lib.purdue.edu/gpo

http://www.usgs.gov/thomes/environ.htm

http://www.usgs

EPA
Summary of State Pollution Prevention Programs

A vast amount of help is available in the environmental community. Answers to environmental questions and solutions to environmental problems pertaining to particular issues are available. When compiling this guideline document, EBMP Committee Members wanted to give the reader a direction on how to begin the process of finding help to resolve or clarify regulatory questions. Following are pollution prevention programs listed by state, and a listing of EPA Regional Offices.

ALABAMA

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Alabama Waste Reduction and
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Alabama Department of
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1751 Congressman William L Dickinson Dr.
Montgomery, AL 36130
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Alaska Health Project
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(907) 276-2864

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Arizona Department of
Environmental Quality
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Phoenix, AZ 85012
(602) 207-4210

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Arkansas Pollution Prevention Program
Arkansas Department of Pollution
Prevention and Ecology
P.O. Box 8913
Little Rock, AR 72219-8913
(501) 570-2861

CALIFORNIA

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Department of Toxic Substances Control
Pollution Prevention, Public and Regulatory
Assistance Division
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P.O. Box 806
Sacramento, CA 95812-0806
(916) 322-3670

Tony Eulo
Local Government Commission
909 12th Street, Suite 205
Sacramento, CA 95814
(916) 448-1198

California Integrated Waste Mgmt. Board
8800 Cal Center Drive
Sacramento, CA 95826
Recycling Hotline: (800) 553-2962
General Public Information: (916) 255-2289

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Colorado Department of Health
4300 Cherry Creek Drive South
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(303) 692-3003

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(COPIRG)
1724 Gilpin Street
Denver, CO 80218
(303) 355-1861

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Connecticut Hazardous Waste Mgmt. Service
900 Asylum Avenue, Suite 360
Hartford, CT 06105-1904
(203) 241-0777

Liz Napier
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Connecticut Department of
Environmental Protection
165 Capitol Avenue
Hartford, CT 06106
(203) 566-5217

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Department of Natural Resources and
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Office of Recycling
D.C. Department of Public Works
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Council of Governments
777 North Capitol Street, NE
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Washington, DC 20002-4201
(202) 962-3355

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Environmental Policy Division
D.C. Department of Public Works
2000 14th Street, NW
Washington, DC 20009
(202) 939-8115

Ms. Ferial Bishop
Administrator
Environmental Regulation Administration
D. C. Department of Consumer and
Regulatory Affairs
2100 MLK Avenue, SE, Suite 203
Washington, DC 20020
(202) 404-1136

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Office of Solid Waste
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Springfield, IL 62794-9276
(217) 785-0533

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Indianapolis, IN 46225
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Waste Management Authority Division
Department of Natural Resources
Wallace State Office Building
Des Moines, IA 50319
(515) 281-8941

KANSAS

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State Technical Action Plan (STAP)
Kansas Department of Health and Environment
Forbes Field, Building 740
Topeka, KS 66620
(913) 296-1603

Lani Himegarner, Program Manager
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Kansas State University RITTA Program
133 Ward Hall
Kansas State University
Manhattan, KS 66506-2508
(913) 532-6026

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Reduction Center
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University of Louisville
Louisville, KY 40292
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LOUISIANA

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Louisiana Department of
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Baton Rouge, LA 70884-2263
(504) 765-0720

MAINE

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State House Station 154
Augusta, ME 04333
(207) 287-5300

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Maryland Department of the Environment
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Jefferson City, MO 65102
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(702) 784-1717

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Division of Environmental Protection
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Curtis Framel
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Carson City, NV 89710
(702) 885-4420

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Waste Management Division and Water Division,
Health and Human Services Building
New Hampshire Department of Environmental Services
6 Hazen Drive
Concord, NH 03301-6505
(603) 271-3503

Air Resources Division
64 North Main Street
Concord, NH 03301-6505
(603) 271-3503

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NEW MEXICO

New Mexico Environment Department
Harold S. Runnels Building
1190 S. St. Francis Drive
Santa Fe, NM 87505-4182
(505) 827-2855 or (800) 879-3421
Air Quality Bureau
(505) 827-0042
Occupational Health and Safety Bureau
(505) 827-4230
Solid Waste Bureau
(505) 827-2775
Underground Storage Tank Bureau
(505) 827-0188

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New York State Department of Environmental
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Hazardous Waste Reduction and
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Office of Air and Waste Management
Pennsylvania Department of Environmental Resources
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Roger Price
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University of Pittsburgh
Applied Research Center
320 William Pit Way
Pittsburgh, PA 15238
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Tennessee Department of Health and Environment
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WASHINGTON

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Joy St. Germain
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WEST VIRGINIA

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Waste Management Section
Pollution Prevention and Open Dump Program
(PPOD)
West Virginia Division of Natural Resources
1356 Hansford Street
Charleston, WV 25301
(304) 558-4000

WISCONSIN

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Kate Cooper, Assistance Recycling Coordinator
Bureau of Solid and Hazardous Waste Mgmt.
Wisconsin Department of Natural Resources
P.O. Box 7921 (SW/3)
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WYOMING

David Finley, Manager
Pat Gallagher, Senior Environmental Analyst Solid
Waste Management Program
Wyoming Department of
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122 West 25th Street
Herschler Building
Cheyenne, WY 82002
(307) 777-7752

Postal Service

Bernie Denno
Environmental Specialist
U.S. Postal Service, Room 6830
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Washington, DC 20260-2810
(202) 268-6014

Tennessee Valley Authority

Paul Schmierbach
Environmental Compliance Department
Tennessee Valley Authority
400 Summit Hill Drive
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(615) 632-6644

Department of Transportation

Janet Krause
Environmental Engineer
Office of the Secretary
Department of Transportation
400 7th Street, SW
Washington, DC 20590
(202) 366-0038

Coast Guard

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Compliance and Restoration Branch
P2 and Recycling Coordinator
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2100 2nd Street, SW
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Federal Aviation Administration

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Department of the Treasury

William McGovern
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Department of the Treasury
Treasury Annex
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Washington, DC 20220
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Department of Veterans Affairs

John Staudt
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Department of Veterans Affairs, 138C-4
810 Vermont Avenue, NW
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EPA Partners for the Environment

Over the last several years, an important change has taken place in our National strategy for protecting the environment. Through an array of partnership programs that we collectively refer to as Partners for the Environment, EPA is demonstrating that voluntary goals and commitments achieve real environmental results in a timely and cost-effective way. In addition to traditional approaches to environmental protection, EPA is building cooperative partnerships with a variety of groups, including small and large businesses, citizen groups, state and local governments, universities, and trade associations.

The results of the Partners for the Environment efforts are impressive. Thousands of organizations are working cooperatively with EPA to set and research environmental goals such as conserving water and energy, and reducing greenhouse gases, toxic emissions, solid wastes, indoor air pollution, and pesticide risk. Our partners are making pollution prevention a central consideration in doing business. Partnership also means that we are working cooperatively with the private sector to provide stakeholders with effective tools to address environmental issues. These partners are achieving measurable environmental results often more quickly and with lower costs that would be the case with regulatory approaches. EPA views these partnership efforts as key to the future success of environmental protection.

If you are involved in:	33/50	AgSTAR	Climate Wise	Coalbed Methane Outreach	CSI	DfE	Energy Star Buildings	Energy Star Residential	Energy Star Office Equipment	Energy Star Transformer	Environmental Accounting	Environmental Leadership	EPA Standards Network	Green Chemistry	Green Lights	Indoor Environments	Landfill Methane Outreach	Natural Gas STAR	Pesticide Environmental Stewardship	Project XL	Ruminant Livestock Methane	State & Local Outreach	Transportation Partners	USIJI	VAIP	WAVE	Waste Wi$e	Waste Minimization National Plan
Manufacturing	X		X		X	X	X	X	X	X	X	X	X	X	X					X				X	X		X	X
Agriculture		X					X		X						X				X	X	X							
Service/Retail/Construction					X	X	X	X	X		X	X	X		X	X			X	X				X		X	X	X
Mining/Energy Extraction			X	X							X		X		X		X	X		X				X				X
Utilities/Transportation		X						X		X	X		X		X				X	X			X	X		X	X	X
Government/Non-profit						X	X	X	X		X		X	X	X					X		X	X	X		X		

EPA Partners for the Environment (Continued)

33/50

Reduce toxic releases of 17 high priority chemicals
202/260-6907

AgSTAR

Reduce methane emissions from manure management
202/233-9041

Climate Wise

Reduce industrial greenhouse gas emissions & energy costs through comprehensive pollution prevention & energy efficiency programs. *An EPA/DOE partnership
202/260-4407

Coalbed Methane Outreach

Increase methane recovery at coal mines
202/233-9468

Common Sense Initiative

Reinvent environmental regulation to achieve cleaner, cheaper, smarter results for six industry sectors: auto mfg; computers & electronics; iron & steel; metal finishing & plating petroleum refining; & printing
202/260-7417

Design for the Environment

Include environmental consideration in product design
202/260-1678

Energy Star Buildings

Maximize energy efficiency in commercial & industrial buildings
202/775-6650

Energy Star Residential

Promote energy efficiency through new home design and residential use of energy efficient products
202/775-6650

Energy Star Office Equipment

Increase manufacture of energy efficient office equipment
202/775-5650

Energy Star Transformer

Increase manufacture and use of high-efficiency distribution transformers by utilities
202/233-9002

Environmental Accounting

Increase business identification of environmental costs, & incorporation of these costs into decision making
202/260-1023

Environmental Leadership

Recognize facilities defined as environmental leaders and promote environmental management systems
202/564-5081

EPA Standards Network

Coordinate Agency involvement in international standards development and provide public information.
202/260-3584

Green Chemistry

Promote and recognize breakthroughs in chemistry that accomplish pollution prevention cost effectively
202/260-2659

Green Lights

Increase use of energy efficient lighting technologies
202/233-9178

Indoor Environments

Reduce risks from indoor air pollution
202/233-9370

Landfill Methane Outreach

Develop landfill gas-to-energy projects
202/233-9042

Natural Gas STAR

Reduce methane emissions from natural gas industry
202/233-9044

Pesticide Environmental Stewardship

Promote integrated pest management & reduce pesticide risk in agriculture & non-agriculture settings
800/972-7717

Project XL

Develop alternative regulatory approaches to achieve greater environmental benefits
202/260-4297

Ruminant Livestock Methane

Reduce methane emissions from ruminant livestock
202/233-9043

EPA Partners for the Environment (Continued)

State and Local Outreach

Reduce greenhouse gas emissions by empowering state & local decision makers.
202/260-4314

Transportation Partners

Reduce carbon dioxide emissions from transportation sector
202/260-3729

U.S. Initiative on Joint Implementation

Promote international projects that reduce greenhouse gases
202/260-6803

Voluntary Aluminum Industrial Partnership

Reduce perfluorocarbon gas emissions from aluminum smelting.
202/233-9793

WAVE

Promote water efficiency in lodging industry
202/260-7288

WasteWise

Reduce business solid waste through prevention, reuse & recycling
800/372-9473

Waste Minimization National Plan

Reduce persistent, bioaccumulative, & toxic chemicals in harzardous waste.
703/308-8438

Internet address at:
http://www.epa.gov/partners or
http://es.inel.gov/partners

TVA
Summary of State Pollution Prevention Programs

STATE	*PROGRAMS*	*CONTACTS*
Alabama	**Alabama Department of Environment & Conservation (ADEM) Advisory Committee**	**Gary Ellis** (334) 213-4303 fax (334) 213-1399
	The University of Alabama - Environmental Institute Research & Service Programs For The Environment • National Institute For Global Environmental Change (NIGEC) • EPA/Experimental Program to Stimulate Competitive Research (EPA/EPSCoR)	**Dr. Robert A. Griffin** (205) 348-1591
	• Gulf Coast Hazardous Substance Research Center	**Dr. Atly Jefcoat** (205) 348-6455
	• Hazardous Materials Management & Resource Recovery (Hammarr)	**William J. Herz** (205) 348-1102
Florida	**Department of Environmental Protection Pollution Prevention Program** • Pollution Prevention at the Source • Onsite Technical Assistance • Pollution Prevention Assessments • Local Government Pollution Prevention Training • Newsletter - P2 Links • P2 in Permits and Inspections • Computerized P2 Source Center • Computerized P2 Source Center of Information & Vendors • Department-Wide Training	**Steffi Tassos** (909) 488-0300 fax (904) 921-8061
	Florida Derm Dade County Pollution Prevention	**Nichole Hefty** (305) 372-6825 fax (305) 372-6760
	Florida Center for Solid & Hazardous Waste Management • Southern Waste Information Exchange Clearinghouse	**Eugene B. Jones** (800) 441-SWIX (7949)
Georgia	**Georgia Environmental Protection Division (EPD)** • Target Industries for Vol. Multimedia Red. • Workshops for the General Public, Ind. Groups Professional and Environmental Organizations • In-House Training for EPD Inspectors • Review of Hazardous Waste Red. Plans (Facility)	**Harold F. Reheis** (404) 656-4713 fax (404) 651-5130
	Georgia EPD Planning Requirement for Large Quantity Generators • Project Petro (Waste Oil Recycling Program)	
	Pollution Prevention Assistance Division • Target Technical & Financial Assistance to Industry (Source Reduction) • Information Clearinghouse • Seniors' Assessment Technical Assistance Program (SATAP) • Quarterly Source Reduction Newsletter • Source Reduction Workshops and Seminars in Cooperation with GTRI • Demonstration Grant Program (with GTRI)	**G. Robert Kerr** (404) 651-5120 **Bob Donaghue** (404) 651-5120 fax (404) 651-5130

TVA
Summary of State Pollution Prevention Programs (Continued)

STATE	*PROGRAMS*	*CONTACTS*
Kentucky	**Kentucky General Assembly HB722 - Info & Technical Assistance Program for Waste Reduction for Kentucky Industries and Businesses. This Program is *Free, Confidential, and Non-Regulatory***	**Ralph Collins** Deputy Commissioner (502) 564-2150
	Kentucky Pollution Prevention Center • On-Site Technical Assistance to Hazardous Waste Generators In Kentucky (Assisted by 6 Retired Engineers) • Free Quarterly Newsletters • Frequent Workshops, Annual Seminars • EPA/State Funding • Gov't Agency (Public Sector) Waste Reduction Assessments • P2 Research	**Cam Metcalf** (502) 852-0965 fax (502) 852-0964 **Debbie Phillips**
	University of Louisville Chemical Engineering Department Industrial Assessment Center (IAC) • Waste Minimization Audits • Options Development • Waste Minimization Research	**Dr. Marvin Fleischman** (502) 852-6357 fax (502) 852-6355
Mississippi	**Comprehensive Pollution Prevention Act of 1990** **Mississippi Pollution Prevention Program** • Coordinator - Hazardous Waste • Coordinator - Solid Waste	**Thomas Whitten** (601) 961-5241 fax (601) 354-6612 **Jim Hardage**
	Mississippi State University **Mississippi Technical Assistance Program (MISSTAP)** • Technology Transfer • Technical Assistance • Waste Exchange • Education • Workshops & Seminars • On-Site Visits & Audits • Information Clearinghouse Library	**Dr. Donald O. Hill** (601) 325-8454 fax (601) 325-8616 **Dr. Caroline Hill** (601) 325-8454 fax (601) 325-8616
North Carolina	**North Carolina Division of Pollution Prevention & Environmental Assistance (DPPEA)**	
	Office of Waste Reduction • On-Site Technical Assistance • R&D Education Projects • Workshops, Outreach, and Seminars • Information Clearinghouse & Library • Recycling	**Gary Hunt** (919) 715-6500 fax (919) 715-6794
	UNC Charlotte, Urban Institute Southeast Waste Exchange "Waste Watcher" • Matches Waste Generators with Waste Management Activities	**Maxie May** (704) 547-2307 fax (704) 547-3178

TVA
Summary of State Pollution Prevention Programs (Continued)

STATE	*PROGRAMS*	*CONTACTS*
South Carolina	**Hazardous Waste Management Research Fund** • Develop & Promote Waste Minimization Technologies	**Betty Branham** (803) 777-9109 fax (803) 777-4575
	Department of Health & Environmental Control (DHEC) **Center for Waste Minimization** • Waste Reduction Advice • Information Clearinghouse • On-Site Technical Assistance • Resource of Free Material for P2 & Waste Minimization	**Bob Burgess** (803) 734-4761 fax (803) 734-9934
	Office of Solid Waste Reduction & Recycling	**Steve Thomas** 1-800-768-7348
	Sumter Technical College **South Carolina Environmental Training Center** • Workshops & Seminars on Solid Waste, Recycling Hazardous Waste, and Waste Minimization • Industry Seminars and In-House Training	**Nancy Bishop** (803) 778-6656 fax (803) 778-7879

The University of Northern Iowa's Recycling Reuse Technology Transfer Center and Iowa Waste Reduction Center

The Recycling Reuse Technology Transfer Center (RRTTC) and the Iowa Waste Reduction Center (IWRC) are located at the University of Northern Iowa, Cedar Falls, Iowa. The RRTTC is an applied research, education, and outreach program which focuses on research related to by-product reutilization and industrial ecology. The IWRC is a small business assistance program which focuses on providing direct assistance to small business clients in regard to environmental regulations and pollution prevention. Both centers work with a diverse clientele. While IWRC is more strictly oriented toward outreach and education in the small business community, the RRTTC bridges the worlds of academia and business by involving students in applied research and internships. What follows are two examples of work with small business, one from RRTTC and the other IWRC.

- RRTTC Assists Small Business Entrepreneurs Develop Fines Compaction Equipment

  A graduate intern with the RRTTC is working with APEX Corporation to assist them in developing a small scale prototype fines compaction apparatus known as the Hanson/Packer. This equipment can be used to separate waste oils and cutting fluids from metal shaving and honing sludges allowing the metal working shop to recover and separate waste oils or cutting fluids from the metal for recycling. The metal is reduced to an 8-10 pound ingot.

  Work is focused on identifying system improvements or manufacturing defects; potential market; the characteristics of the melts from formed ingots; and any potential regulatory barriers for use with this equipment on site with the small metal working shop. A patent has been obtained for various system components.

- IWRC Assists Small Surface Coating Operation to Reduce Their VOC Emissions

  The Surface Technique and Research (STAR) training project has been a very successful effort. Information used to develop the STAR training program was first obtained through applied research in surface coating techniques and evaluation. Careful study of and experimentation with various approaches to spray plan of attack, estimation practices, and thoughtful selection of surface coating equipment provided the basis for this effective and practical training program.

  STAR efforts have focused on disseminating and conducting training programs both with private businesses and state technical assistance providers. Training sessions have involved shop personnel from small autobody operations and state and regional technical assistance programs.

  This education/outreach effort focuses on training the surface coater to increase transfer efficiency, improve build efficiency, reduce build variation, and improve finish quality, while reducing overspray emissions and waste. Through the use of STAR program techniques, significant improvements in operator dependent variables are achieved by carefully training the operator in regard to best practices for optimum pollution prevention in the areas of coating mixture, proper use of chosen equipment type, maintenance practices, gun set-up, spray distance and angle, spray technique, and plan of attack. An integral part of the STAR program is the training manual entitled "Increased Profits Through Efficient Spraying."

Point of Contact

For further information about this program, please contact:

Catherine Zeman, Program Manager
Recycling Reuse Technology Transfer Center
University of Northern Iowa
2244 McCollum Science Hall
Cedar Falls, IA 50714-0421
(319) 273-7090
FAX (319) 273-5815
E-mail: catherine.zeman@uni.edu

Environmental Programs for the State of Iowa

The State of Iowa, through its comprehensive network of state and local environmental programs, is assisting business and industry to make environmentally sound business decisions. The following programs are available to business and industry for technical and/or financial assistance:

Waste Reduction Assistance Program

Beth Hicks
Iowa Department of Natural Resources
900 East Grand Avenue
Des Moines, IA 50319-0034
(515) 281-8927
Fax: (515) 281-8895
E Mail: ehicks@max.state.ia.us

The Waste Reduction Assistance Program (WRAP) provides:

- Business and industry no-cost, confidential, non-regulatory assistance with waste reduction and recycling;
- Industry consultants who lend technical assistance to businesses and organizations of more than 100 employees;
- On-site opportunity assessments, workshops and on-going information transfer on pollution prevention technologies;

Connections to pollution prevention resources, including searches via the internet, access to an extension library, connection to waste exchanges, regional and national newsletters and journals, and vendor lists to meet manufacturers needs.

Landfill Alternatives Financial Assistance Program

Tom Anderson
Waste Management Assistance Division
Iowa Department of Natural resources
900 East Grand Avenue
Des Moines, Iowa 50319-0034
(515) 281-8623
Fax: (515) 281-8895
E-mail: tanders1@max.state.ia.us

The Iowa Department of Natural Resources, Waste Management Assistance Division administers a financial assistance program that provides incentives for alternatives to landfilling solid wastes and market development. Financial assistance is awarded on a competitive basis. Funding for this program is provided by a portion of the tonnage fees assessed on every ton of solid waste landfilled in the State of Iowa. Applicants are required to provide a minimum cost share toward project costs.

Landfill Alternatives Financial Assistance Program (LAFAP)

- Projects eligible to receive a grant include public education projects; waste reduction at the source projects; research and development projects (new technologies); and demonstration projects that are new to the State of Iowa.

- Projects eligible to receive a zero interest loan include projects that do not meet the above criteria; recycling and reuse projects; combustion with energy recovery projects; and combustion for volume reduction projects. The term of loans awarded through this program are negotiated.
- Two funding cycles are offered each year. Application deadlines are 4:30 p.m. the first Monday in June and 4:30 p.m. the first Monday in December.

Recycling Equipment Sales Tax Exemption

- Industrial machinery, equipment, computers and replacement parts are tax exempt if used primarily in recycling or reprocessing waste products. Contact: Department of Revenue and Finance, (515) 281-3114.

Recycling Equipment Property Tax Exemption

- Personal and real property are tax exempt if used primarily in converting waste plastic, waste paper, or waste paperboard into raw materials or products composed primarily of recycled material. Contact: Department of Revenue and Finance, (515) 281-3114.

Recycle Iowa

Margo Underwood
200 East Grand Avenue
Des Moines, IA 50309
(515) 265-0889
Fax: (515) 265-6690

Recycle Iowa is a cooperative program between the Iowa Departments of Economic Development and Natural Resources. Recycle Iowa is assisting to achieve the state-wide 50% recycling goal and improve Iowa's environment by developing and expanding markets for recyclables. New and expanded recyclable markets also increase capital investments and employment opportunities for Iowans.

The goals of the Recycle Iowa program are:

- To encourage community-based economic development through expansion of markets for recyclables.
- To foster resource conservation attitudes, practices and policies in Iowa by identifying economic incentives that encourage recycling market development.
- To facilitate the use of recyclables in Iowa industry to produce recycled products and stabilize value-added markets.
- To stimulate and stabilize the balance of supply and demand of recyclable materials and recycled products in Iowa.

By-product and Waste Search Service Iowa Waste Exchange

Iowa Waste Exchange Administration and Support

Leisha Barcus
Recycle Iowa Office
200 East Grand Avenue
Des Moines, IA 50309
(515) 242-4755
Internet: http://www.recycleiowa.org.

Environmental Programs for the State of Iowa (Continued)

Iowa Waste Exchange Technical Contractor

Jennifer Drenner
Iowa Waste Reduction Center
75 Biology Research Complex
University of Northern Iowa
Cedar Falls, IA 50614-0185
(800) 422-3109 or (319) 273-2079
Fax: (319) 273-2926

Iowa's Waste Exchange (IWE) is Iowa's free, confidential By-product and Waste Search Service. Administered by the Recycle Iowa Office, this is a cooperative effort between the Iowa Department of Natural Resources, the Iowa Department of Economic Development, Iowa community colleges, councils of governments and the Iowa Waste Reduction Center. The IWE staff meets with business people to:

- Identify your company's waste streams;
- Facilitate transfer of materials by actively searching for companies and non-profit organizations to reuse or recycle them;
- Save your company money in avoided disposal costs; and
- Locate valuable secondary materials for potential use in your business, saving your company money on the purchase of new materials.

Iowa Department of Economic Development

Peggy Russell
Marketing and Business Expansion Bureau
200 East Grand Avenue
Des Moines, IA 50309
(515) 242-4735
Fax: (515) 242-4749

The Department of Economic Development (DED) offers financial assistance programs to aid in economic development through a variety of programs.

Iowa Manufacturing Technology Center

Del Shepard
DMACC, Building #3E ATC
2006 South Ankeny Boulevard
Ankeny, IA 50021
(515) 965-7125
E-mail: iowamtc@exnet.iastate.edu

The Manufacturing Technology Center (MTC) offers single-contact resources connecting small and mid-sized manufacturers to all of the varied pools of knowledge that once worked independently. The MTC is a state-wide network with field agents available to conduct formal assessments of a manufacturer's needs to develop plans and coordinate delivery of services to meet manufacturing needs. In addition, the MTC assists in modernizing facilities, upgrading processes and improving the work force through the use of effective training and skill development.

Environmental Programs for the State of Iowa (Continued)

Iowa Recycling Association

c/o Recycle Iowa Office
Margo Underwood, President
2 Post Road
Mason City, IA 50401
(515) 265-0889
Fax: (515) 265-6690

The Iowa Recycling Association (IRA) is a non-profit association of businesses, government agencies, non-profit organizations and individuals who believe that waste reduction and recycling are good for the environment and for economic development. The IRA focuses on:

- Educating the public about the increasing importance of waste reduction and recycling;
- Advising government about solid waste management;
- Developing new markets for recyclable materials;
- Collecting and processing recyclables and remanufacturing them into useful products;
- Shaping public policy on recycling.

Iowa Waste Reduction Center

University of Northern Iowa
75 Biology Research Center
Cedar Falls, IA 50614-0185
(800) 422-3109 or (319) 273-2079
Fax: (319) 273-2926

The Iowa Waste Reduction Center (IWRC) helps small business owners and operators meet and exceed environmental regulations; and reduce costs through pollution prevention. The Center provides free, confidential on-site environmental assistance to small businesses (200 employees or fewer). Other programs at the IWRC include:

- Iowa Air Emissions Assistance Program - assistance with air permitting and regulations for small business.
- Small Business Pollution Prevention Center - applied research and education outreach for critical small business environmental issues.

Recycling and Reuse Technology Transfer Center

Catherine Zeman
University of Northern Iowa
2244 McCollum Science Hall
Cedar Falls, IA 50314-0185
(319) 273-7090

The purpose of the RRTTC is to promote and support research, education and outreach for solid waste reuse and recycling technologies and processors. RRTTC projects target key Iowa industries and solid waste streams in order to reduce the amount of wastes sent to Iowa landfills, with the overall goal of preventing

environmental degradation while promoting Iowa's economy. Established by the Iowa State Legislature, the RRTTC supports research projects to:

- Identify and design new reuse and recycling technologies;
- Transfer emerging and existing technologies and manufacturing processes to new industries;
- Disseminate research findings and encourage implementation.

Climate Wise

Anne Black
Iowa Department of Natural Resources,
Energy Bureau
Wallace State Office Building
Des Moines, IA 50319
(515) 242-5851
Fax: (515) 281-6794

Climate Wise is a result of the Climate Change Action Plan—a historic international environmental agreement signed by President Clinton in 1993. The Plan calls for signatories to return greenhouse gas emissions to 1990 levels by the year 2000. In keeping with these goals, Climate Wise encourages comprehensive, cost-effective industrial energy efficiency and pollution prevention actions, and allows companies to tailor their programs to meet the needs and opportunities of their operations. Climate Wise:

- Targets the industrial sector;
- Is conducted as a full partnership between the Environmental Protection Agency and the Department of Energy;
- Promotes emissions reduction through voluntary public/private sector partnerships;
- Provides support for a broad array of emissions reduction opportunities.

Rebuild Iowa

Linda King
Iowa Department of Natural Resources,
Energy Bureau
Wallace State Office Building
Des Moines, Iowa 50319
(515) 281-7015
FAX: (515) 281-6794

GOAL: Reduce energy consumption in participating buildings by 25% and increase economic development by using local businesses, financiers, and contractors.

Rebuild Iowa is a program designed to assist communities seeking to increase economic development by implementing energy efficiency improvements in community buildings. Participants include, but are not limited to, the following buildings: schools, hospitals, local government buildings, commercial and industrial buildings, multi-family dwellings, and residential housing. A coordinator in each community acts as a marketer of the program and as a liaison with the Department of Natural Resources to provide communities with information to improve local economies through energy efficiency.

The Rebuild Iowa program is based on the following steps:

- Identify building improvements and their anticipated economic pay back through an analysis;
- Estimate dollar savings from those improvements;
- Implement improvements in community buildings.

Total Assessment Audit

Anne Black
Iowa Department of Natural Resources,
Energy Bureau
Wallace State Office Building
Des Moines, IA 50319
(515) 242-5851
Fax: (515) 281-6794

William Haman, P.E.
Iowa Energy Center
2521 Elwood Dr.
Ames, IA 50010-8263
(515) 294-4710
Fax: (515) 294-9912

The Total Assessment Audit (TAA) program is available for private industry interested in identifying wasteful energy and manufacturing practices. TAA offers solutions which allow industry to compete in a global market by analyzing production costs and complying with environmental standards, while eliminating excessive use of energy in the production process. The TAA format provides comprehensive and accurate analyses of industrial facilities to identify:

- Opportunities for investment in energy efficiency technologies;
- Options to improve economic competitiveness and viability through new or converted technologies;
- Possible opportunities to reduce pollution and contamination of natural resources while improving production in facilities.

Energy Analysis and Diagnostic Center

Dr. Howard Shapiro
Iowa State University
2088 Black Engineering Building
Ames, IA 50011-2160
(515) 294-3080

The Energy Analysis and Diagnostic Center (EADC) provides tenured faculty from Iowa State University College of Engineering to guide senior and graduate engineering students as they analyze your plant's energy use. Free and confidential, this energy audit will reveal simple ways to cut energy use quickly, often with a very small capital investment.

This energy audit is available for all types of manufacturing. Your company is eligible for EADC services if your plant's products are within the standard industrial classification codes 20 through 39 and if you are located within about 150 miles of Iowa State University. Your plant must also:

- Have gross annual sales of $75 million or less;
- Consume energy at a cost of $100,000 to $1.75 million per year;
- Employ no more than 500 people;
- Have no technical staff to do energy analysis.

Every effort has been made to verify the information provided in each entry. No warranty, expressed or implied, and no endorsement of any facility, business, organization or individual is suggested by inclusion or exclusion of this list.

Rockwell Avionics & Communications

Solid Waste Environmental Leadership and Learning Team

At Rockwell, our Vision is to be the best diversified, high technology company in the world. To attain this goal, we truly have to be *the best* in all areas, including our prudent use of resources— those of our company, our community, and our planet. Rockwell's comprehensive waste reduction and reuse program was expanded in January 1993 at Collins Avionics and Communications Division's (CACD) Coralville, Iowa location. This production facility dealt with a mountain of potential recyclables each day, ranging from plastic bags to package padding and electronic packaging materials.

With the assistance of the By-product and Waste Search Service (BAWSS)—Iowa's waste exchange program—Coralville kicked off a program in which many "waste" items could be reused within the facility, sold, given to other companies, or shipped back to the suppliers who pay the freight. Not only has this landfill avoidance been a boon to the environment, it also translates into revenues of more than $75,000 annually. This savings provides the funding for the continuation of Rockwell's recycling program.

Rockwell has found an excellent means to process recyclables while contributing to the community. Many packaging materials are shipped to Goodwill Industries of Southeast Iowa, where mentally and physically challenged employees at the Rehabilitation Center grade and prepare these materials for reuse or recycling. This provides jobs to these valuable members of our community while freeing Rockwell employees from having to divert time away from work to process recyclables.

CACD leadership chartered a cross-functional team to develop a similar initiative for the Cedar Rapids, Iowa and Anamosa, Iowa facilities after having been convinced of the effectiveness of the program by the Coralville results and corporate accolades. This Solid Waste Environmental Leadership and Learning (SWELL) team soon grew to encompass Collins Commercial Avionics (CCA) and Rockwell Graphic Systems (Goss). The SWELL program has been presented to numerous businesses, agencies and recycling organizations nationally and internationally as well as corporate-wide at Rockwell.

How did the SWELL program come so far so fast? One of the critical elements is commitment—on the part of both employees and leadership. This includes a strong company/union partnership, which has been invaluable to the success of the program. Bargaining unit employees are an important part of the SWELL team, and a strong partnership between Union and Rockwell management has paved the way for the team's progress. The cross-functional, multi-level nature of the team has also helped the program's implementation—when a recyclable item finds its way into the garbage, there more than likely is a SWELL team member nearby to pass along a gentle reminder to the offender. The program relies on the support, ideas and dedication of all for its success.

It is for this very reason that education is so important. Successful waste minimization requires a day-to-day commitment for accurate source separation of recyclable items. Rockwell's division-wide clean out your office days have not only provided an excellent way to rid the facility of excess items and free up valuable floor space, but they gave employees the best possible opportunity to learn the recycling guidelines—through practice. For the first such event, held on Earth Day, 1995 at CACD, the SWELL team published a booklet of guidelines in addition to populating work areas with well-marked recycling bins.

Employees were encouraged to wear casual attire for the day-long event, which further boosted participation. Other clean out your files day have followed; the SWELL principles were put into action April 23, 1996 at the State of Iowa's "Clean Your Files Day" on the Capital Complex, where forty-six and a half tons of material were collected in under five hours. Rockwell was proud to team with Iowa's Department of Natural Resources and Department of General Services to make this far-reaching clean-up a reality.

Rockwell's employees environmental awareness has also provided an opportunity for employees to make a contribution to Goodwill Industries. The workforce at Rockwell has the option of on-site drink can and bottle redemption ($.05 can deposit in Iowa) but almost all choose to leave the beverage cans in designated receptacles for Goodwill donation which resulted in a donation of over $10,000 in FY96.

We at Rockwell feel we have the responsibility to share what we know—both our successes and lessons learned—with other companies and organizations. We recently captured the principles championed by SWELL in a "how to" document. The resulting 11-step booklet, the "World Class Resource Recovery &

Recycling Program Guide," has been distributed to all of Rockwell's North American operations and to several other businesses to assist them as they kick off their own environmental waste minimization programs.

You can have the most successful recycling program in the world, but unless you have a market for recycled items, your efforts are futile. To facilitate end use opportunities for collected materials, The National Buy Recycled Business Alliance and several state Buy Recycled programs have been working to encourage businesses to consider recycled goods when making office and facility purchases. If a business has not looked at recycled content materials recently, the cost, quality, and availability of today's supplies will surprise them.

There are some odd items for which we have not yet found a market—a selection of miscellaneous plastics and foam "trash." However, this "trash" became treasured works of art in the hands of hundreds of area children during the Iowa City Artfest, held in the summer of 1996. In response to the SWELL team's "Junk Art" craft tables at the festivals, many teachers continually approach Rockwell about receiving a supply of these "unrecyclable" items for future art projects.

As you undoubtedly realize, "It's not easy bein' green" . . . it requires planning, education, and a great deal of commitment. Even so, a waste reduction and reuse program brings with it some hefty dividends—not just to a company's bottom line, but to the environment and the community. When we lend a hand to other companies piloting their waste reduction programs, we have reached another step closer to attaining our Vision.

Appendix C

Point of Contact Directory

Air Force Plant #44 Hughes Missile Systems Company - Tucson, AZ

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Bell Helicopter Textron, Inc. - Fort Worth, TX

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Bell Helicopter Textron, Inc. (BHTI), located in Forth Worth, Texas, is a manufacturer of commercial and military helicopters. Bell employs about 7,000 workers. BHTI began full scale development of the V-22 (Osprey) in 1984 with Engineering Manufacturing Development activities beginning in October 1993. The V-22 vertical takeoff aircraft program is the first major weapon system acquisition for Bell Helicopter requiring a pollution prevention plan. The tilt rotor technology is being developed jointly by Bell Helicopter and Boeing Helicopters of Philadelphia, Pennsylvania.

City of Chattanooga - Chattanooga, TN

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Chattanooga, Tennessee is located at the juncture of the states of Tennessee, Georgia and Alabama and is surrounded by the southern Appalachian mountains and Cumberland Plateau. Nestled in the heart of the Tennessee River Valley, Chattanooga is home to more than 152,000 people and is part of Hamilton County that supports a population in excess of 285,000. The City's economic base includes a diverse group of businesses including Coca-Cola, MoonPies, Brock Candies, Olan Mills, Provident Insurance, Dixie Yarns, and numerous heavy industry representatives. A city with a heavy manufacturing base, Chattanooga was designated in 1969 by the then-U.S. Health, Education and Welfare Department as one of the most polluted cities in the United States. Since that critical turning point, Chattanooga has evolved into a benchmark for environmental improvement with a strong commitment to sustainable development through economic growth.

The City's long and sometimes painful journey was acknowledged in 1990 when the EPA recognized Chattanooga for its clean air and in 1995 designated it on Earth Day as America's most improved city.

What makes this turnaround effort so significant was the concerted effort between government, business organizations, and the community to work together first on individual problems, then as part of a more coherent "vision" for Chattanooga's future. What became apparent during the late 1960s to early 1980s was that the citizens wanted not just change, but continuously maintainable development so that protection of the environment incorporated economic growth and quality of life for all of Chattanooga. This evolutionary initiative, begun in the late 1960s, became an infusive vision manifested in several programs such as the Chattanooga Venture, the Chattanooga Neighborhood Enterprise, the Greenway initiative, Riverpark, and the Electric Bus program.

What began as a response to overwhelming problems has evolved into a highly successful, interrelated series of programs and projects for Chattanooga. Building on what matters to its citizens—the environment, quality of life, and sustainable growth—the City continues to canvass, analyze, and incorporate goals and objectives to ensure that it stays a model, environmentally-supportable city that listens and cares not just about the environment, but about the generations of Chattanoogans who will inherit it.

Dayton Parts, Inc. - Harrisburg, PA

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Dayton Parts Inc. (DPI), located in Harrisburg, PA, was originally founded as Stanley Springs in 1921, and its original product line of heavy-duty leaf springs used on tractors, trailers and other heavy equipment has remained central to the company's business. The company became Dayton Parts in 1988 and kept the Stanley Springs name for its spring line and its repair facility. Acquired by JPE, Inc. in 1992, DPI manufactures and/or distributes truck and automotive components for the original equipment market and aftermarket and sells to heavy-, medium-, and light-duty truck and trailer independent companies. Its primary customers are independent warehouse distributors, mega distributors, wheel and rim distributors, and spring service outlets for heavy duty and medium duty commercial vehicles and related equipment.

The spring manufacturing plant is well-equipped and features state-of-the-art taper spring manufacturing equipment. Supporting a work force of approximately 120 non-union employees, the plant is capable of producing more than 17,000 spring types and typically manufactures over 5,000 spring part numbers per year with 60% of these in lot sizes ranging from 1 to 40. Typical big lots average between 100 and 200. Leaf spring products currently represent approximately 80% of the manufactured product with the tapered spring line expected to grow from its current 20% in the future.

Defense Contract Management Command - Ft. Belvoir, VA

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Department of Energy, Oak Ridge Operations - Oak Ridge, TN

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Located in the city of Oak Ridge, Tennessee, Department of Energy, Oak Ridge Operations encompasses 35,252 acres of land and embraces three primary research and technology facilities (Oak Ridge National Laboratory, Oak Ridge Y-12 Plant, and East Tennessee Technology Park) as well as supportive organizations.

Operated by Lockheed Martin Energy Research Corporation, the Oak Ridge National Laboratory conducts applied research and engineering development to advance the Nation's energy resources, environmental quality, scientific knowledge, educational foundations, and industrial competitiveness.

Operated by Lockheed Martin Energy Systems, Inc., the Oak Ridge Y-12 Plant provides weapon components dismantlement; highly-enriched uranium storage and management; nuclear weapon stockpile support; environmental restoration; waste management activities; precision manufacturing; and national security programs. The Oak Ridge Centers for Manufacturing Technology, also located at Y-12, provides manufacturing technology transfer programs that are available to the Nation's private sector as well as other federal customers.

Also operated by Lockheed Martin Energy Systems, Inc., the East Tennessee Technology Park provides leading-edge research, development, and implementation of environmental restoration and waste management technologies related to monitoring, handling, decontaminating, decommissioning, treatment, and storage.

Oak Ridge serves the Nation through the Oak Ridge Centers for Manufacturing Technology by maintaining core competencies related to weapon manufacturing, providing access to user facilities, operating the manufacturing skills campus, and providing opportunities via technology transfer programs. Success results by combining the overlapping research and development capabilities of the Oak Ridge National Laboratory, the unique manufacturing technologies of the Y-12 Plant, and the environmental restoration experience of the East Tennessee Technology Park.

As the training arm of the Oak Ridge Centers for Manufacturing Technology, the Manufacturing Skills Campus offers intense hands-on and performance-based training courses for government, industry, and academia. The Campus features national broadcasts on industry-relevant topics via remote electronic hook-up, and a virtual training model which reduces traditional cost and schedule barriers.

Oak Ridge Operations continues to advance in quality, excellence, and research. This spirit continues to characterize Oak Ridge's activities as it builds on its historic strengths; delivers scientific and technological value; and establishes itself as an efficient, cost effective complex regarded for its high excellence, ethics, and integrity.

Digital Equipment Corporation - Westfield, MA

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(Important: Business has since been sold.) Located in Westfield, Massachusetts, the Digital Equipment Corporation (DEC) Enclosures Business encompasses 225,000 square feet with a staff of 600 employees in support of the total business. DEC Westfield, together with its facility located in Maynard, Massachusetts, provides sheet metal fabrications finishing and assembled enclosures from single tools to model, prototypes and high volume products. Westfield's fabrication and assembly flexibility is enhanced by CNC equipment under DNC control, design-to-manufacturing connectivity through electronic transfer, and a computer-controlled EPA compliant paint system. In addition to Westfield's manufacturing capabilities, services offered through DEC Enclosures Business include the use of information technology to manage the business, sheet metal versus plastic analysis, concurrent engineering, material management, and integrated work cell manufacturing teams.

Dover Air Force Base - Dover, DE

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Dover Air Force Base (DAFB) is home to the 436th Airlift Wing, more commonly known as the "Eagle Wing", and the 512th Airlift Wing, the Reserve associate, referred to as the "Liberty Wing." C-5 Galaxy airplanes, the largest transport aircraft in the Air Force, are flown by both wings, who form the "Dover Team." The base covers more than 3,900 acres which house some 1,700 buildings. DAFB's economic impact is more than $470 on the local economy and is Delaware's third largest industry.

The Dover Team's mission is essentially to provide global airlift capability. DAFB also houses the world's largest aerial port, which moves more cargo than Federal Express and UPS combined.

The Charles E. Carson Center for Mortuary Affairs, DAFB's port mortuary also plays a vital role as a place of honor where the remains of Department of Defense personnel killed overseas are received. The Charles E. Carson Center for Mortuary Affairs will be formally dedicated on 28 May 1997.

Hamilton Standard Electronic Manufacturing Center - Farmington, CT

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The Hamilton Standard Electronic Manufacturing Center (HSEMC) in Farmington, Connecticut is a functional unit of the Hamilton Standard division of United Technologies Corporation. This facility covers over 160,000 square feet and supports almost 400 employees. Operations include production of electronic systems for flight controls for the Black Hawk helicopter, CH53/MH53 helicopter and Seahawk helicopter. In addition, HSEMC produces electronics for the data systems for the F/A-18, C-17, and F-15 aircraft, as well as the Apache and Comanche helicopters. Electronic systems are also included in the missile engine controls for the Harpoon missile. HSEMC also produces precision sensors for military aircraft, helicopters, and missiles.

The Hamilton Standard Electronic Manufacturing Center provides any company with a roadmap for applying good management techniques and sound business practices—and ensuring its successful application by strong support from highly motivated and trained personnel. This effort is providing HSEMC with an environment of opportunity to expand its share of the global marketplace. The company is well on the road to world class manufacturing through strong communication procedures and individualized application of common practices.

ITT Defense and Electronics - Mclean, VA

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ITT Defense and Electronics (ITT D&E) is a leading supplier of high technology commercial and defense electronic systems, semiconductors, standard and customized connectors and operations and management services. Its primary business markets include avionics, data communications, instrumentation, military/space and transportation cus-

tomers. With annual sales of approximately $1.7 billion and 15,000 employees, ITT Defense and Electronics has operations in North America, Europe, Asia, and the Middle East, and is one of three business segments of ITT Industries.

Kurt Manufacturing Company - Minneapolis, MN

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Kurt Manufacturing Company produces precision machine parts and assemblies for the computer, aircraft, compressor, fluid power, and defense industries. The product lines include rotary transfer machines, machine tool accessories, industrial vises, electronic machine controllers, electronically-controlled modular gaging and statistical analyzers, and shop hard computers. Kurt also provides contract services to manufacturers in areas such as prototype development, special machine tool construction, and precision die castings.

Kurt Manufacturing comprises seven divisions housed in eight separate facility sites. Six of the eight plants are located in the Minneapolis, Minnesota area with additional sites in Pueblo, Colorado and Layman, Nebraska. Kurt Manufacturing includes the Machining Division, Screw Machine Division, Industrial Products Division, Electronic Division, Die Casting Division, Machine Tool Division, and Gear Division. The work force of more than 1,100 employees is housed in over 580,000 square feet company-wide.

Lockheed Martin Electronics and Missiles - Orlando, FL

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Lockheed Martin Electronics and Missiles (E&M) is headquartered in Orlando, FL with additional sites in Ocala, FL; Pike County, AL; Goldsboro, NC; and other U.S. and international locations. Part of the Lockheed Martin Electronics Sector located in Bethesda, MD, E&M maintains three primary product mission areas—Missile Systems, Fire Control Systems, and Advanced Systems. Varied technologies are key to these missions such as electro-optics, millimeter wave radar, image and signal processing, miniaturized and large scale ICs, and multi-sensor fusion. Over 5,000 employees occupy E&M facilities that encompass more than 3,000,000 square feet.

Like many defense-related industries and companies, Lockheed Martin Electronics and Missiles is successfully adapting to changes in the market environment. Continually benchmarking itself against the internal and external "best," integrating what it learns in a closed-loop process, and applying conscientious efforts to produce high-quality products for its customer, Lockheed Martin Electronics and Missiles continues to produce practices that are among the best in industry and government.

Lockheed Martin Tactical Aircraft Systems - Ft. Worth, TX

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Lockheed Martin Tactical Aircraft Systems (LMTAS) is a government-owned, contractor-operated facility designated as Air Force Plant 4, located

adjacent to the realigned Carswell reserve base in Ft. Worth, Texas. This division of Lockheed Martin employs over 11,900 personnel with a 1994 payroll of $677.76 million. Facilities encompass 602 acres with over seven million square feet of building space. LMTAS supports several major programs including the Air Force's F-16 Fighting Falcon, FS-X, and F-22 Air Superiority Fighter aircraft. In addition, LMTAS is leading Lockheed Martin's effort in the Joint Advanced Strike Technology program to develop future tactical aircraft for the Navy, Marines, and Air Force.

In 1988, General Dynamics had a corporate strategy of protecting the environment and achieving zero discharge of all hazardous wastes. This policy was forward-looking and successfully generated LMTAS' present-day, proactive emissions remediation management program. More than 50 successful zero-discharge projects have been completed, and pollution prevention initiatives have saved the company more than $25 million on hazardous waste disposal. The result of LMTAS' environmental program was its selection to receive the Clean Texas 2000 1995 Governor's Award for Environmental Excellence.

Companies such as Lockheed Martin Tactical Aircraft Systems will continue to meet considerable challenges for many years. However, building on past successful practices—like its environmental program—and cultivating current programs such as its Lean Enterprise Initiative and solid supplier relations, LMTAS is adapting to and excelling in a highly competitive arena.

Overall Point of Contact for Lockheed Martin Tactical Aircraft Systems' Success Stories and Technical Point of Contact for Low Vapor Pressure Cleaning Solvent Success Story:

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Technical Point of Contact for Use & Verification of Aqueous Alkaline Cleaners:

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Mason & Hanger Corporation - Middletown, IA

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Mason & Hanger Corporation is the operating contractor of the government-owned Iowa Army Ammunition Plant (IAAP), a 19,000 acre production facility located near Middletown, Iowa. The IAAP is a primary Load/Assemble/Pack facility for the manufacture and demilitarization of conventional ammunition for the Army. A major process function is the high explosive loading of ammunition, by either the meltcast method or by mechanical pressing. In addition to the production operations, Mason & Hanger has a Development facility, Chemical Laboratory, Metrology Laboratory, Test Fire Facility and a staff of engineers, scientists and technicians. Current employment at the facility is in excess of 900 Mason & Hanger employees, along with another 20 government employees.

Mason & Hanger Corporation, Pantex Plant - Amarillo, TX

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The Mason & Hanger Corporation (M&H) is the management and operating contractor at the Department of Energy (DOE) Pantex Plant located outside of Amarillo, TX. This DOE facility covers more than 16,000 acres, and Mason & Hanger is responsible for more than 3,000 employees. With an additional staff of 600 from various government agencies and contractors such as Battelle Memorial Institute and Sandia National Laboratories, Pantex is the only facility tasked with the assembly, disassembly, repair, and retirement of the nation's nuclear weapons. Although originally constructed during World War II as a conventional bomb construction plant, Pantex has evolved into a facility with five primary operational missions including: to fabricate chemical high explosive components for nuclear weapons; to assemble nuclear weapons for the nation's stockpile; to maintain and evaluate the nuclear weapons in the stockpile; to disassemble nuclear weapons from the stockpile; and to serve as an interim storage site for plutonium components from retired weapons.

Security and safety are critical issues to Pantex employees because of the nature of the nuclear assembly/ disassembly processes. Relating closely to these issues are the environmental and human health and safety concerns for on-site personnel and the surrounding population. The plant has highly-developed and sophisticated security and environmental elements that work intently with the government agencies to ensure total control of the processes from cradle to grave. These elements include a 550-person Security Force, as well as Environmental Safety & Health, Waste Management, Environmental Restoration activities. This facility is in a strong position to meet the new needs of the Department of Energy triggered by changes in the world environment. Integrating its capabilities, applying its developed technology, and initiating benchmarking beyond the facility's borders are among the best in government and industry.

McDonnell Douglas Aerospace - St. Louis, MO

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McDonnell Douglas Aerospace (MDA) (St. Louis) is a leading producer of tactical and training aircraft, military transport aircraft, strike missiles, military and commercial helicopters, space launch vehicles, space platforms, defense systems, C^4I systems, and related services. Products include the F/A-18 (C/D and E/F), F-15, AV-8B, T-45 and Harpoon/SLAM. Principal customers include the Department of Defense and foreign governments such as the Netherlands and Great Britain. The MDA (St. Louis) complex houses MDA management and support functions as well as program management and fabrication/assembly facilities for the F/A-18, production aircraft, and the Harpoon/SLAM. Research and testing facilities, test and flight simulation laboratories, a manufacturing technology development center, and prototype airframe manufacturing facility also reside in St. Louis.

With the current funding environment unlikely to change in the near future, every company engaged in defense-related work is examining, streamlining, and adjusting its programs to competitively manufacture high quality, affordable products.

McDonnell Douglas Aerospace (St. Louis) is answering this challenge by learning from past experiences, incorporating the best of its capabilities and personnel into its Integrated Product Definition process, and continually benchmarking itself against world-class competitors to provide its customers with economical, superior quality products. These activities have been integrated into MDA's product lines and are producing impressive results, considered among the best in industry and government.

Millar Western Pulp (Meadow Lake) Ltd. - Saskatchewan, Canada

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Millar Western Pulp (Meadow Lake) Limited is the world's first successful zero-liquid effluent pulp mill. The company has 200 employees at its site, its mill produces totally chlorine free Bleached Chemi-Thermo-Mechanical Pulp (BCTMP). The company is a dynamic, innovative team dedicated to maintaining its site as a model of environmental excellence and leadership.

In conducting business the company is committed to:

- meeting or exceeding all applicable laws and regulations,
- continuously improving its systems, technologies and process to minimize its environmental impact of both current and future operations, ensuring pollution prevention is considered at every stage of the process,
- setting measurable annual objectives and maintaining reliable processes for tracking its environmental performance
- fostering openness and dialogue with its employees, the public, and its customers; anticipating and responding to their concerns about potential hazards and impacts of the company's operations, products, and wastes, and
- encouraging its suppliers and contractors to perform their operations in a manner that is consistent with the company's environmental policy

NASA Marshall Space Flight Center - Huntsville, AL

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Marshall Space Flight Center (MSFC) was established in 1960 and is a field installation of NASA. MSFC is recognized as a national leader in propulsion systems; payload design, development and integration; and science investigations. Its extensive areas of expertise include management of complex programs; systems engineering and integration; systems development; payload systems analysis and integration; the technical disciplines encompassing propulsion systems, structural systems, material science and engineering, electronics, guidance, navigation and control, power systems, data systems, environmental control and life support systems; optical systems and science and applications areas of astrophysics, earth science and applications, low gravity science, and solar terrestrial physics.

With 3,700 employees occupying over 1,800 acres in the U.S. Army Redstone Arsenal in Huntsville, Alabama, MSFC also includes facilities in the Michoud Assembly Facility in New Orleans, Louisiana, the Yellow Creek Production Facility in Mississippi, the Slidell Computer Complex in Slidell, Louisiana, and the John C. Stennis Space Center in Mississippi. MSFC facilities include structural and test-firing facilities for large space systems, and specialized laboratories for studies and facilities for assembling and testing large space hardware.

MSFC's specific capabilities include:

- Scientific and engineering activities associated with design, development, test, mission operations and evaluation of space launch vehicle transportation systems and payloads.
- Planning and conceptual development of new programs in support of MSFC and NASA objectives.
- Technical services and program support activities including facilities planning, construction and maintenance, purchasing, contract administration, technology utilization, computer operations, and communications support.

NASA and its Centers have long been advocates of technology transfer with a deep commitment that goes beyond legislatively dictated efforts. This commitment is strongly manifested in MSFC's exemplary relationship with contractors. Not only does this relationship enhance the technology and expertise transfer between NASA and contractor, but also among contractors. This environment, coupled with a strong positive attitude among personnel, contributes to a teamwork atmosphere where employees are open to new ideas, and projects are pursued with excellence through continuous improvement. A grass roots TQM effort has already begun, is influencing many aspects of project work, and is gaining momentum among management with impressive results. The guiding principle towards achieving MSFC's goals of excellence and continuous improvement is supported by a strong dedication to learning new ways of doing things and sharing that technology and expertise with industry and other government activities.

Nascote Industries, Inc. - Nashville, IL

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Nascote Industries, Inc., formed in 1985, is one of three plants run by the Conix Corporation, a joint venture between Magna International (51%) and the Ford Motor Company (49%). The company, located in Nashville, Illinois has 600 employees and is a major supplier of exterior trim products to the automotive industry. Sales for 1995 reached $120 million. Although teaming constitutes a critical component of Nascote's success, maintaining a workforce with highly-developed skills and experience is just as important. With an average employee age of 29 and a strong work ethic, the Nascote employee provides a valuable resource to the plant and represents a pivotal factor in the company's receiving the General Motors Fascia Supplier of the Year award in both 1994 and 1995.

The company's environmental efforts represent another instance of Nascote's emphasis on quality. To reduce operationally-produced hazardous waste such as paint fumes, sludge, and solvent, Nascote implemented several changes including the installation of a state-of-the-art thermal oxidation system to destroy volatile organic compound emissions. The company also contracts with outside agencies to recycle the paint sludge into products used by other industries. In addition, Nascote has instituted cleaning its paint solvent for reuse. The company's commitment to the workforce and the environment is paralleled only by its commitment to producing a quality product.

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The Naval Aviation Depot (NADEP)-Jacksonville is one of six industrial facilities that performs rework, repair, and modification of aircraft, engines, and aeronautical components. NADEP-Jacksonville covers over 100 acres of land on the St. John's River in Jacksonville, Florida and maintains a work force of over 2,500 personnel. Depot maintenance is performed on the P-3 Orion, T-2 Buckeye, F/A-18 Hornet, S-3 Viking and A-7 Corsair. NADEP-Jacksonville is the Navy's premier engine facility and reworks jet engines and over 36,000 components and avionics.

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The Crane Naval Surface Warfare Center is a large Navy facility covering 100 sq. miles in southern Indiana. It has a compliment of about 3,400 personnel. Its mission is to provide low cost, quality, and responsive acquisition, engineering, logistics, and maintenance for the Fleet's weapon and electronic systems, ordnance, and associated equipment and components. This will be accomplished in partnership with industry, academia, and government activities.

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Naval Surface Warfare Center, Indian Head Division (IHDIV) is located at Indian Head, Maryland, employs more than 2,000 people, and encompasses approximately 3,400 acres of land divided between two peninsulas along the eastern shore of the Potomac River. The larger peninsula is designated as the IHDIV; the smaller peninsula (about 1,100 acres) is designated as the Naval Surface Warfare Center, Stum Neck Annex IHDIV command, while operations at Stump Neck Annex are conducted by a tenant of IHDIV, the Naval Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV). In addition, the Naval Explosive Ordnance Disposal School, (NAVSCOLEOD), which is also a tenant, conducts operations both mainside and at Stump Neck.

IHDIV is the oldest continuously operating Naval ordnance facility in the United States. Established in 1890 as aproving ground for Naval guns, the Activity has evolved from a "powder factory" to a critical source of specialized ordnance devices and components serving the Army, Navy, and Air Force. The main production focus is energetic materials. Some examples of these materials are propellants, explosives, and pyrotechnics. Energetic materials are used for the nation's defense in items such as aircrew escape propulsion systems, rocket motors, mines, mine countermeasures, torpedoes, and warheads. IHDIV has full-spectrum capabilities in energetics research, development, engineering, manufacturing technology, limited production, industrial base support, test and evaluation, and fleet/operation support. As a tenant command of the IHDIV, the NAVEODTECHDIV's mission is to provide explosive ordnance disposal technology and logistics management for the Joint Services; and develop war essential elements of intelligence, equipment and procedures to counter munitions both U.S. and foreign, as required to support the DOD.

IHDIV's mission is to work on energetic products for all areas of Naval Warfare. While a significant portion of the work is performed for the Army, Air Force, and private defense contractors, IHDIV primarily works Navy unique ordnance, i.e. ordnance unique to surface combatants and submarines. Another facet of IHDIV's mission is to develop production sector. In time of war, IHDIV has the technical expertise to kickstart the nation's dormant ordnance industry.

The Indian Head Division, Naval Surface Warfare Center has recently been honored with the following Department of Defense awards: Naval Sea Systems Command Excellence Awards; Chief of Naval Operations Environmental Awards; Secretary of the Navy Environmental Awards; and Secretary of Defense Environmental Security Awards.

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Located in the state of Washington, the Naval Undersea Warfare Center (NUWC) Division Keyport is the Navy's sole repair and maintenance depot for torpedoes and undersea mobile targets. In this capacity, Keyport—with remote sites in Hawaii, Southern California, and Hawthorne, Nevada—provides test and evaluation, depot maintenance and repair, In-Service Engineering, and fleet industrial support for torpedoes and other undersea warfare systems including mobile mines, unmanned underwater vehicles and countermeasures. Further efforts include responsibility for undersea combat systems and foreign military sales to almost 39 Allied countries. To support these activities, Keyport maintains and operates three underwater, three-dimensional tracking range sites with the capability to conduct vendor acceptance and in-service testing and evaluation of undersea weapons.

At Keyport's main site, some 600 of the 3,100 resident civilian and military personnel, together with more than 200,000 square feet of industrial shops, are dedicated to processes that span prototype development to manufacturing and refurbishment of small components and entire systems. Keyport was noteworthy in many areas, but particularly in its environmental stewardship efforts and its "total quality way of life." These two concepts are firmly entrenched in the activity's policies, processes, and employee attitude.

Located in the environmentally conscious Northwest, Keyport is expected to have a solid environmental program.. The efforts in this area are extensive, with the program extending to the supplier level. Keyport personnel are very conscious of the environmental impact of hazardous material disposal and are very conversant with the companies with which they do business. For example, Keyport determined that there were only two companies of the many authorized to do business with the Navy, that are correctly disposing of laser toner cartridge material and consequently have contracted exclusively with them. This awareness is not legislatively dictated, but is an attitude in all Keyport personnel. It was recognized by the Secretary of the Navy in 1993 when Keyport received the first ever Meritorious Unit Commendation (to every employee) for Environmental Achievement.

Norden Systems, Inc. (Northrop Grumman Norden Systems) - Norwalk, CT

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Norden Systems, Inc. (now Northrop Grumman Norden Systems) is a subsidiary of United Technologies and is headquartered in Norwalk, Connecticut. Norden designs, develops, and manufactures advanced electronics systems for military use. These systems are currently incorporated in combat vehicles, aircraft, ships, submarine and missiles. The U.S. Navy's A-6E and EA-6B, the Air Force's F-111B and B-52, the Army's Battery Computer System and Multiple Launch Rocket System, and the joint Army/Air Force JSTARS represent just a few of Norden Systems' major programs. In addition to contracts with the Department of Defense, Norden also provides advanced radar capabilities to the Federal Aviation Administration for use at civilian airports around the United States.

Over 3,000 employees are housed at the Norwalk facility with an additional 2,000 personnel located

at Norden's facilities in New York and Maryland. The Norwalk facility contains manufacturing and engineering operations as well as research and development laboratories. The company operates hybrid microelectronics development and manufacturing, environmental testing, radar system integration, and indoor and outdoor radar test ranges. At the Melville, New York facility, Norden conducts shipboard and ground systems development and manufacturing. In Gaithersburg, Maryland, Norden personnel provide engineering services, software development and shipboard emulation equipment for land-based sites.

Oak Ridge National Laboratory - Oak Ridge, TN

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As one of the world's largest commodity chemical producers, Occidental Chemical Corporation (OxyChem®) operates the chemical business of the Occidental Petroleum Corporation. Headquartered in Dallas, Texas, OxyChem retains the service of over 10,000 employees. The 44 manufacturing facilities located worldwide are committed to global excellence in business, health, safety and the environment. With sales of $5 billion in 1995, its operations are in the major business groups of basic chemicals, polymers and plastics, speciality chemicals, and petrochemicals.

Basic chemicals include facilities producing chlor-alkali products. OxyChem is the largest merchant marketer of chlor-alkali products in the United States. Chlorine is used in water treatment, semiconductors, medical devices, coatings, adhesives and pharmaceuticals. Nearly 60% of its chlorine production is utilized to produce vinyl chloride plastic and resins. Polyvinyl chloride (PVC) resins are widely used in residential and commercial pipe, window frames, house siding, flooring, wall coverings, and a multitude of auto, consumer and home products.

The OxyChem polymers and plastics group produces PVC molding plastics that are used in automotive, household and industrial products. The plants in this group manufacture PVC copolymer dispersion resins and PVC speciality resins. OxyChem is also a major producer of petrochemicals for use in products ranging from packaging, bottles, and bags to textiles, construction materials and detergents. Specialty business products, including phenolic resins, chrome chemicals, silicates, PVC film, speciality resins bonding products, fire-retardant additives, and plastic molding compounds are used in home, auto, aerospace and industrial applications. The speciality chemical division also produces a unique and environmentally friendly alternative solvent known as OXSOL® that offers regulatory compliance while providing the performance of many traditional solvents.

Pacific Northwest National Laboratory - Richland, WA

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The Pacific Northwest National Laboratory (Pacific Northwest) is a U.S. Department of Energy (DOE) research laboratory operated by Battelle Memorial Institute. Energy and environmental technology research and development is the mission of Pacific Northwest. A wide variety of technology research programs are conducted at Pacific Northwest, including material sciences, molecular biology, health physics, information management, national security, chemical processing, environmental surveillance and monitoring, and other technology planning and analysis research, in support of DOE, the Department of Defense, and industrial clientele. Pacific Northwest has approximately 3,600 employees.

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Dr. Edwin Land founded the Polaroid Corporation in 1937. Although best known as the inventor of the instant photography process and the Polaroid Land camera, Dr. Land was a strong social advocate. For example, he started a family practice health clinic for his employees and their families; established a safety program in the 1950s; and initiated environmental efforts in preparation for the first Earth Day in 1970. Originally, Polaroid produced light polarizing filters. Today, the company designs, manufactures, and markets instant imaging recording products worldwide, such as instant photographic cameras and films; electronic imaging recording devices; conventional films; and light polarizing filters and lenses. With its corporate headquarters located in Cambridge, Massachusetts, Polaroid maintains eight U.S. sites, employs 8,500 personnel worldwide, and achieved $2.5 billion in revenues for 1996.

Polaroid's Waltham (Main Street), Massachusetts site employs 1,200 personnel and encompasses 150 acres. Featuring Polaroid's Chemical Operations Division, this site synthesizes chemical components used in Polaroid film; manufactures chemical reagents; coats photographic materials; assembles technical and industrial film products; and performs research, engineering, and wastewater treatment. Polaroid promotes proactive approaches; open communication; environmental and safety commitments; and community involvement.

Raytheon Missile Systems Division - Andover, MA

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Raytheon Missile Systems Division (MSD) is a division of the Raytheon Corporation's Electronics segment. Headquartered in Bedford, Massachusetts, Raytheon MSD also has additional sites in Andover, Lowell, and Tewksbury, Massachusetts, as well as Bristol Tennessee. These sites cover more than 3,000,000 square feet and house over 16,000 employees. The MSD product line includes many foremost missile systems currently in use by the U.S. Armed Forces and international customers. These systems include the Patriot and Hawk Air-Defense Systems, Stinger Surface-to-Air Missile, Standard Missile-2, Sparrow Missile, Sidewinder Missile and Advanced Medium Range Air-to-Air Missile.

Rockwell Autonetics Electronics Systems (Boeing North American A&MSD) - Anaheim, CA

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Rockwell Autonetics Electronics Systems (AES) is a subsidiary of the Rockwell International Corporation. AES comprises five major divisions employing more than 8,500 people. Facilities cover over 200 million square feet on 200 acres over six sites. The division's main headquarters are located in Anaheim, California with additional sites in San Bernadino, California; Norcross and Duluth, Georgia; El Paso, Texas; and Australia.

The Marine Systems Division specializes in antisubmarine warfare electronics, ship systems, and navigation and control systems. Antisubmarine Warfare Electronics has produced several systems with capabilities in acoustic signal recording, processing, analysis and displays. Ship Systems designs, builds, and installs ship systems such as the Data Multiplex System, BSY-1 Own Ship Data Set,

and a range of ship system engineering and simulation services. Navigation and Control supplies and supports inertial navigators for ballistic missile submarines used by both the United States and United Kingdom.

The Autonetics Sensors and Aircraft Systems Division (AS&ASD) serves as an electronics integrator and supplier of systems hardware. AS&ASD designs and develops integrated avionics systems, aided target acquisition and classifications systems, and sensor systems including millimeter wave, laser radar, infrared and multi-sensor system. AS&ASD also has the capabilities to create new hardware, electrical designs and software for operational flight programs, as well as to modify fire control systems, navigation systems and stores management systems.

Autonetics ICBM Systems Division researches and produces highly reliable leading-edge solutions for Air Force deployed ICBMs and develops launch control and security systems for the Peacekeeper Rail Garrison Program. The Division has perfected developments in guidance technology and is advancing command and control capabilities for strategic weapon systems and land battle management. The Missile Systems Division produces accurate, low cost guided weapon systems. They pioneered the application of television and laser precision guidance to tactical weapons including Hellfire, the GBU-15 guided weapon system and its powered version, the AGM-130.

Rockwell Collins Avionics and Communications Division - Cedar Rapids, IA

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Rockwell Collins Avionics and Communications Division (CACD) is a world leader in electronic information distribution, processing, and control. In its communications effort, Rockwell CACD's capabilities include air, land, sea, satellite, C^3I, and ECCM efficiencies; information distribution systems, and displays. On the navigational end, CACD produces cockpit and flight management systems, integrated avionics, and advanced programs in both communication and navigation. These capabilities translate into the business applications of communications/ information transport, customer support, advanced high frequency information systems, navigation/information collection, advanced concepts, and integrated applications. CACD's almost 4,000 employee workforce is headquartered in Iowa, with one facility in Cedar Rapids covering 596,000 square feet, and another in nearby Coralville encompassing 140,000 square feet. In 1987, the company was known as Collins Defense Communications. Since that time, this company has undergone changes and consolidation, and has seen the defense industry experience much the same.

There is a strong undercurrent of constructive change, supported by a collective, positive attitude. "Doing more with less people" does not constitute an obstacle to CACD; it represents a challenge and one that Rockwell is meeting. The company remains outward-looking—continually open to new ideas and technology—and is a strong advocate for technology transfer.

There are two programs that highlight this technology transfer philosophy — the Sequential Electrochemical Reduction Analysis (SERA) Solderability Assessment Technology Program, and the Reduced Oxide Soldering Activation (ROSA™) Solder-

ing Technology Program. The SERA process determines the type and degree of oxidation present on a solder surface by electrochemically removing the oxides from the solder surface and measuring the voltage/charge associated with the removal process. The use of this technology has facilitated the reduction of solder defects in a production environment. ROSA™ is a new method of removing oxidation of copper, tin, and tin-lead surfaces through electrochemical reduction for use in mass soldering processes. This technology has been shown to be a practical means of ensuring solderability without the use of CFC solvent materials for removing flux residue.

Rockwell CACD is a company making difficult adaptations to the defense industrial base shift, but is doing so successfully through careful application of the systems and philosophies exhibited in the HPWS and through programs such as STEP. These efforts have proven successful as evidenced by the CACD Coralville facility's selection as one of the top 25 finalists in *Industry Week* magazine's fifth annual "Best Plants" contest in 1994. The contest targets companies that exemplify manufacturing excellence and are committed to world class competitiveness and continuous involvement. By implementing and supporting forward-thinking programs, Rockwell CACD will maintain and expand its share in the world marketplace.

Sandia National Laboratories - Albuquerque, NM

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Sandia National Laboratories (SNL) is a Department of Energy (DOE) multiprogram national effort that maintains sites in New Mexico and California with test facilities in Nevada and Hawaii. Headquartered in Albuquerque, NM and operated by the Sandia Corporation, a wholly-owned subsidiary of Martin Marietta, SNL employs over 8,500 personnel and has an annual budget of more than $1.4B. The laboratories have facilities for manufacturing process development, environmental testing, renewable energy, radiation research, combustion research, computing, and microelectronics research and production.

Sandia's research-based engineering efforts are solidly based on a matrix of core competencies. Comprised of two critical elements, research foundations and integrated capabilities, Sandia's core competencies have been developed and advanced by 40 years of research and development in nuclear weapons, energy, environmental, and work for other government agencies. These core competencies are critical to SNL's long term success and constitute their singular capabilities in the national laboratory field. Engineered processes and materials, computational and information sciences, microelectronics and phototonics, and engineering sciences comprise Sandia's four major research foundations. These are complemented by and rely on the laboratories' integrated capabilities of Advanced Manufacturing Technology, Advanced Information Technology, Electronics, and Pulsed-Power.

Originally tasked with nuclear weapon development, SNL has expanded their mission beyond that of researching and developing programs for solutions to military security, energy security, environmental integrity, and work for other government agencies. SNL now also maintains a goal to team with industry in programs to include advanced manufacturing technologies, improved transportation, cost-effective health care, and information/computation science and technology. These new responsibilities are in response to the changing global environment and Sandia's endeavor to share technology to enhance America's global competitiveness and the national quality of life.

As one of the premier laboratories in the nation, Sandia offers industry and government a rich research and development resource. Sandians have researched and assiduously recorded information on complete process life cycles - information which industry needs. From years of experience in scientific areas, Sandia has also examined and developed numerous related technological concepts which have practical applications in the industrial arena. For example, the design-for-environment system EcoSys™ can provide designers and process engineers with perspectives on the relative environmental impact between alternate designs. This in-

formation system taps into detailed life cycle, product, process, and material data that is critical to the analysis.

Sandia National Laboratories is staffed with personnel who are innovative, independent-thinking, motivated, and represent a critical element of this national resource. This high level of expertise is as much a strength of SNL as the transferable technology. This combination of personnel, research and development proficiency, and technical capabilities makes Sandia a vital element in maintaining the United States' energy security as well as its environmental integrity and global economic competitive position.

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Sullivan Graphics is an international commercial printing company. It has 22 locations across the U.S. and Canada. Sullivan's annual sales are in excess of $500 million and it employs over 2,200 people. The primary business product is newspaper advertising inserts, book publishing, and publications. In 1994, the Sullivan plant in Marengo, IA won the Iowa Governor's award for waste reduction in a non-manufacturing facility.

Texas Instruments, DS&EG - Dallas, TX

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Texas Instruments Defense Systems and Electronics Group (TI DS&EG) is one of five groups in the Texas Instruments company. TI DS&EG is comprised of three separate entities including Avionics Systems, Weapons Systems, and Advanced Technology. Headquartered in Dallas, Texas, the DS&EG group of Texas Instruments is housed in facilities located in Lewisville, Texas; Austin, Texas; Colorado Springs, Colorado; Denton, Texas; and Sherman, Texas.

With their facility at the Expressway, Dallas, Texas, the Advanced Technology Entity produces microwave devices/ components, advanced IC products, IR FPA detectors, artificial intelligence, high density packaging, advanced systems, computer processing, and information processing.

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Today, with nearly 22,000 civilian and military assigned to the base, logistics work is just part of Tinker's mission. After the arrival of the Navy, Tinker became one of DOD's premiere interservicing facilities. Not only is total support of America's defense systems a priority, but protecting and enhancing the environment is a top concern as well. Through the use of aggressive and innovative technologies, Tinker has become a national leader in pollution prevention.

Tinker's largest organization is the Oklahoma City Air Logistics Center (OC-ALC), one of five depot repair centers in the Air Force Materiel Command. The OC-ALC is the worldwide manager for a wide range of aircraft, engines, missiles and commodity items. The center manages an inventory of 2,267 aircraft which include the B-1, B-2, B-52, C/KC-135, E-3, VC-25, VC-137, and 25 other Contractor Logistics Support aircraft.

The Center also manages an inventory of more than 13,724 jet engines that range from the Korean Conflict vintage J33s (T33) to state-of-the-art B-2 engines such as the F118. Missile systems managed by the center include the Air Launched Cruise Missile, Short Range Attack Missile, Harpoon and Advanced Cruise Missiles. Commodities management includes responsibility for some 42,399 different exchangeable or commodity items.

United Defense, L.P., Ground Systems Division - Santa Clara, CA

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FMC Corporation and Harsco Corporation formed a limited partnership in January 1994 to become the largest manufacturer of tracked, armored combat vehicles in the United States. United Defense, Limited Partnership (L.P.) is 40% owned by Harsco, and FMC, the managing general partner, owns 60%. Brought together, FMC's Defense Systems Group and Harsco's BMY Combat Systems Division provide engineering and systems integration skills; research and development in principal technologies; flexible manufacturing and conversion of light, medium, and heavy vehicles made from aluminum, steel, and composites; and proven logistics support proficiency. Headquartered in Arlington, Virginia, United Defense, L.P. maintains worldwide engineering, manufacturing, and service sites in locations such as Santa Clara and San Jose, California; Anniston, Alabama; York, Pennsylvania; Tabuk, Saudi Arabia; Fridley, Minnesota; Ankara, Turkey; and Aiken, South Carolina.

U.S. Army Combat Systems Test Activity (Aberdeen Test Center) - Aberdeen, MD

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The U.S. Army Combat Systems Test Activity (CSTA) (now Aberdeen Test Center), located at Aberdeen Proving Ground in Maryland, provides a premier range and test facility for the Department of Defense. Chartered in 1917 to provide testing of field artillery, weapons and ammunition, CSTA now operates under the Army's Test and Evaluation Command (TECOM) and has become a world class, all purpose testing center. CSTA encompasses state-of-the-art facilities and equipment, advanced instrumentation, and comprehensive support capabilities to test a wide range of military weapons systems, equipment, and materiel. Testing covers the full range of life cycle support from concept evaluation and research prototypes through advanced development to quality assurance testing of production items. Testing is primarily performed for the Army, Navy, Air Force, and Marines, but CSTA also offers its services to other government agencies and private industry as well.

Capabilities at CSTA are sustained by scientists, engineers, mathematicians, technicians, and support employees, totaling 1,000 military and civilian personnel. These capabilities include the ability to design, develop, and construct state-of-the-art instrumentation incorporating advanced technologies necessary to keep pace with testingrequirements of current military systems. Soldiers from the field participate as members of test teams, bringing valuable field experience and training to the test effort. Located on 52,000 acres, CSTA maintains numerous exterior and interior firing ranges, automotive courses, environmental chambers that simulate temperature conditions, underwater explosive test ponds, non- destructive test facilities, and an extensive industrial complex to support equipment maintenance and experimental fabrication. These capabilities are used in the three principal directorates for technical management including Live Fire Vulnerability, Automotive and Support Equipment, and Armament and Advanced Technology.

Appendix D

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